INSTRUCTION MANUAL

PRODUCTION ENGINEERING

TYPE CA PLUG-IN

DEPT. 333

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

INSTRUCTION MANUAL

Serial Number 73293

PRODUCTION ENGINEERING

TYPE CA PLUG-IN

DEPT. 333

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0318-01

666

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

New material copyright © 1961, 1966 by Tektronix, Inc., Beaverton, Oregon. Printed in the United States of America. All rights reserved. Contents of this publication may not be reproduced in any form without permission of the copyright owner.

CONTENTS

Section 1	Characteristics
Section 2	Operating Instructions
Section 3	Circuit Description
Section 4	Maintenance
Section 5	Performance Check
Section 6	Calibration
	Parts Ordering Information
	Abbreviations and Symbols
Section 7	Electrical Parts List
	Mechanical Parts List Information
Section 8	Mechanical Parts List
Section 9	Diagrams
	Mechanical Parts List Illustrations

Abbreviations and symbols used in this manual are based on, or taken directly from, IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

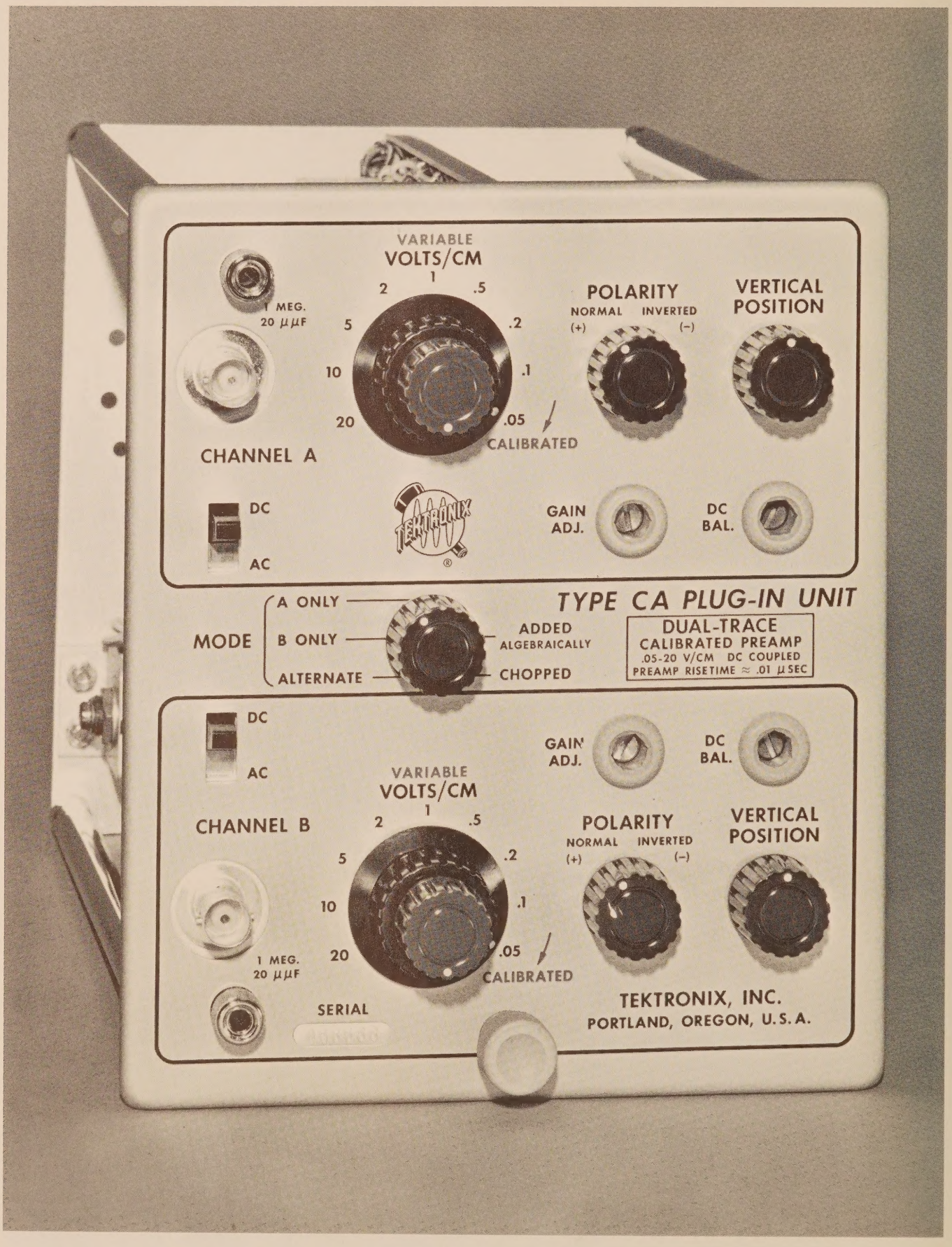


Fig. 1-1. Type CA Plug-In Unit.

SECTION 1
CHARACTERISTICS

General Information

The Type CA Plug-In Unit contains two identical calibrated preamplifier channels. Either channel can be used independently to produce a single display or electronically switched to produce dual-trace displays. In addition both channels can be combined at the output, adding or subtracting according to the settings of the polarity switches.

For single or dual-trace operation, each channel has its own input selector, attenuator, gain, polarity and position controls which makes possible adjustments of the display for optimum viewing and information.

In dual-trace operation there are two operating modes, chopped or alternate. An innternal multivibrator switches the channels at a free-running rate of about 100 kHz in the chopped mode of operation. In the alternate mode of operation, the time base generator in the oscilloscope switches the channels at the end of each sweep during the retrace interval.

The Type CA can be used with any of the Tektronix 530-, 540-, or 550-Series Oscilloscopes. It can also be used with the 580-series Oscilloscopes and in conjunction with other oscilloscopes and devices through use of the Tektronix Types 127, 132, or 133 plug-in power supplies.

ELECTRICAL CHARACTERISTICS

Amplifier Transient Response and Bandwidth

Your Type CA was adjusted at the factory for optimum transient response. Table 1-1 summarizes the risetimes and approximate bandwidths available when the CA Unit is used in combination with various oscilloscopes.

TABLE 1-1

Amplifier Transient Response and Bandwidth

Oscilloscope-CA Unit Combination	Risetime	Bandwidth (at —3 dB points)	
	Either Channel AC or DC Coupling	Either Channel DC Coupling	Either Channel AC Coupling
541A, 543B, 544, 545A, 545B, 546, 547 555, 581A[1], 585A[1]	15 ns	DC to 24 MHz	2 Hz to 24 MHz .2 Hz to 22 MHz with 10× probe
551	16 ns	DC to 22 MHz	2 Hz to 22 MHz .2 Hz to 20 MHz with 10× probe
531A 533A 535A	26 ns	DC to 13.5 MHz	2 Hz to 12 MHz .2 Hz to 12 MHz with 10× probe
536	35 ns	DC to 10 MHz	2 Hz to 10 MHz .2 Hz to 10 MHz with 10× probe

[1]**Type 81 Plug-In Adapter required for use with 580-series Oscilloscopes.**

Amplifier Sensitivity

Nine calibrated steps are provided for each channel: .05, .1, .2, .5, 1, 2, 5, 10 and 20 volts/cm. Variable controls for each channel permit continuous (uncalibrated) adjustment from .05 volts/cm to 50 volts/cm.

Operating Modes

Channel A Only

Channel B Only

Alternate—Triggered electronic switching of channels at the end of each sweep, during the retrace interval.

Chopped—Free-running electronic switching of channels at about a 100 kHz rate. The sweep trace for each channel is chopped into segments. Each trace segment has an on time (displayed time) duration of about 5 μs; off time between segments is about 5 μs.

Added Algebraically—Both channels are combined at the output, adding or subtracting according to the settings of the polarity switches. When subtracting, common-mode rejection is at least 20 to 1 over the entire bandwidth for signals up to 1 V amplitude.

Polarity Inversion

Polarity of either channel can be inverted for comparison of signals 180° out of phase.

Input Coupling

Choice of AC or DC coupling. In the AC positions a coupling capacitor is inserted, limiting the low-frequency response to about 2 Hz (—3 dB) direct, or 0.2 Hz (—3 dB) using a 10× attenuator probe.

Input Impedance

1 megohm paralleled by approximately 20 pF.

Physical Characteristics

Construction—Aluminium-alloy chassis.

Finish—Anodized aluminum front panel.

Accessories

Standard accessories supplied with this instrument will be found in the Mechanical Parts List. For optional accessories, see the current Tektronix, Inc. catalog.

NOTES

SECTION 2

OPERATING INSTRUCTIONS

FUNCTIONS OF FRONT-PANEL CONTROLS AND CONNECTORS

The functions of all controls, adjustments, and connectors except the MODE switch are identical for both channels.

Input Connector	Signal input connector for the channel.
AC—DC	Slide switch to provide either AC or DC coupled input into the amplifier.
VOLTS/CM	Nine-position switch to select the calibrated vertical deflection factors.
VARIABLE	Potentiometer to provide continuously variable attenuation between the calibrated sensitivities and to extend the attenuation to a deflection factor of 50 volts/cm. This control does not have a mechanical stop, and is therefore continuously variable. It does, however, have a detent stop for the CALIBRATED position.
POLARITY	A two-position switch that presents the input signal in a normal or inverted polarity on the CRT of the associated oscilloscope.
GAIN ADJ	Screwdriver-adjust potentiometer to set the gain of the amplifier accurately.
VERTICAL POSITION	Potentiometer to control the vertical position of the trace.
DC BAL	Screwdriver-adjust potentiometer to set the amplifier DC level so the trace does not shift position as the VARIABLE control is adjusted.
MODE	Five-position switch that sets the mode of operation as follows.

A ONLY—Allows the use of CHANNEL A only.

B ONLY—Allows the use of CHANNEL B only.

ALTERNATE—Dual-trace operation with triggered electronic switching between channels during the retrace interval.

CHOPPED—Dual-trace operation with free-running electronic switching of channels occuring at about a 100-kHz rate.

ADDED ALGEBRAICALLY—Permits adding of the outputs of the two channels.

FIRST-TIME OPERATION

The following procedure will help you become familiar with the Type CA Unit operation.

1. Insert the Type CA into the oscilloscope, tighten the Securing Rod, and turn the oscilloscope power on.

2. Allow about 2 to 3 minutes warm-up time and free run the oscilloscope sweep at 1 msec/cm.

3. Set the applicable Type CA front-panel controls for both channels as follows:

AC—DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED
POLARITY	NORMAL
VERTICAL POSITION	Centered
MODE	A ONLY

4. Position the trace about one cm above the graticule center line with the CHANNEL A VERTICAL POSITION control.

5. Set the MODE switch to B ONLY and position the trace one cm below the graticule center line with the CHANNEL B VERTICAL POSITION control.

6. Set the MODE switch to ALTERNATE. Both CHANNEL A and B traces should be displayed.

7. Set the oscilloscope Time/cm switch to 50 msec. Note that, for each sweep cycle, one channel is displayed and the other is shut off. Electronic switching from one channel to the other occurs during the retrace interval.

8. Set the MODE switch to CHOPPED. Notice that both traces seem to start simultaneously and continue across the CRT.

9. Set the oscilloscope Time/cm switch to .1 msec and adjust the oscilloscope trigger controls to obtain a stable display. Notice that each trace is composed of many short-duration bits or segments with visible switching transients existing between channels (Fig. 2-1A).

10. To see the chopped-mode switching action clearly, increase the sweep rate to 2 μsec/cm. Notice that CHANNEL A is on for about 5 μs while CHANNEL B is off for 5 μs for the first half-cycle. Then for the last half-cycle, CHANNEL B is on for 5 μs while CHANNEL A is off (Fig. 2-1B). Chopping rate per channel, determined by the free-running multivibrator switching rate, is about 100 kHz.

11. Blank out the switching transients between channels by setting the CRT Cathode Selector switch (located on the rear panel of most Tektronix oscilloscopes) to the Dual-Trace Chopped Blanking position (Fig. 2-1C).

12. Set the oscilloscope Time/cm switch to 1 msec. Using coaxial cables, a T connector connected to CHANNEL A and a connector adapter (if calibrator has a UHF connector), apply 0.1 volt from the oscilloscope Amplitude Calibrator to the CHANNEL A and B Input connectors.

13. Both CHANNEL A and B calibrator waveforms should be displayed. Each waveform should be 2 cm in amplitude.

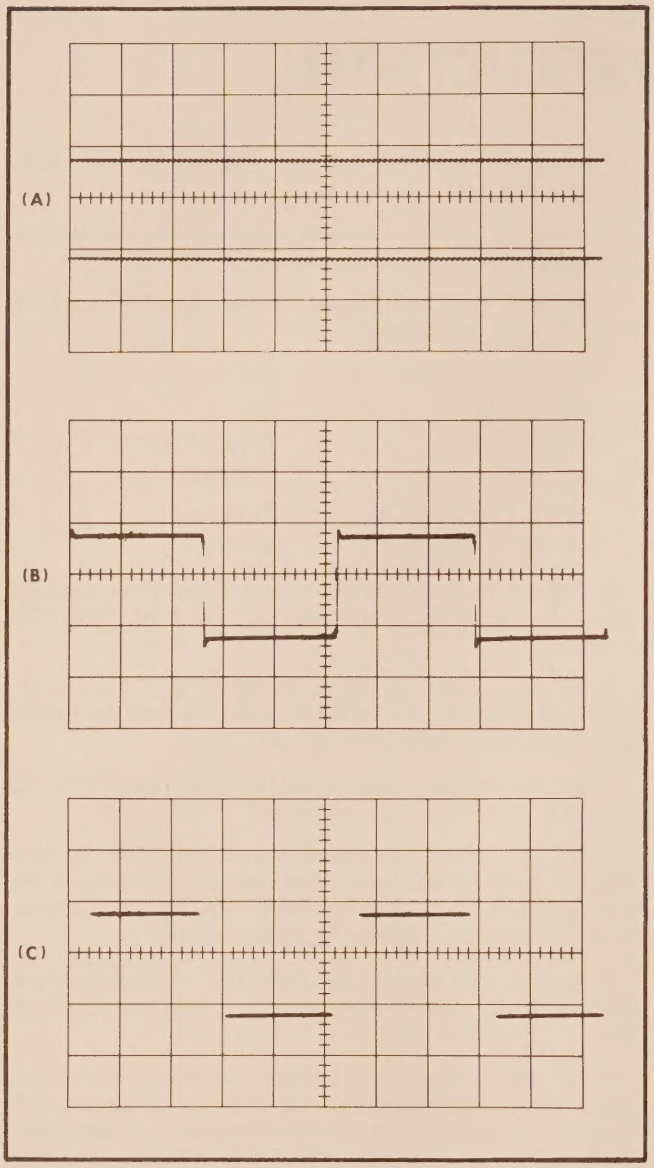


Fig. 2-1. Chopped-mode waveforms: (A) trace broken up into segments, (B) chopped-mode switching action from channel to channel, and (C) switching transients blanked out.

NOTE

If the waveforms are not exactly 2 cm in amplitude, overlook the inaccuracy until completing this operating procedure. Subsequent paragraphs describe how to properly set the gain of the unit.

14. Now set the MODE switch to ADDED ALGEBRAICALLY. There should be one waveform display 4 cm in amplitude. This is the addition of the CHANNEL A and B signals (2 cm each). Notice that either VERTICAL POSITION control will move the display vertically.

15. Set the CHANNEL A POLARITY switch to INVERTED and free run the time base. The display should be a straight line, indicating the algebraic difference between the two signals. Since both signals have equal amplitudes and waveshape, the difference is zero.

Before the Type CA is used for accurate measurements, the GAIN ADJ and DC BAL front-panel adjustments for each channel should be adjusted. These adjustments are described in the following paragraphs.

Gain Adjustments

The gain adjustments should be checked periodically to assure correct vertical deflection factors, particularly when the Type CA is used for the first time or is moved from one oscilloscope to another. Use the following procedure to check the gain of each channel.

1. Set the applicable Type CA front-panel controls for both channels as follows:

AC—DC	DC
VOLTS/CM	.05
POLARITY	NORMAL
VERTICAL POSITION	Centered
VARIABLE	CALIBRATED (detent)
MODE	A ONLY

2. Set the oscilloscope sweep rate and triggering controls for a 1 msec/cm free-running sweep.

3. Apply a 0.1 volt peak-to-peak signal from the Standard Amplitude Calibrator through a coaxial cable to the CHANNEL A Input connector.

4. The resulting display should be exactly 2 cm in amplitude. If not, adjust the CHANNEL A GAIN ADJ control for correct amplitude. (Use the CHANNEL A VERTICAL POSITION control to align the display with the graticule markings.)

5. Set the MODE switch to B ONLY and apply the calibrator signal to the CHANNEL B Input connector.

6. The display should be exactly 2 cm in amplitude. If not, adjust the CHANNEL B GAIN ADJ control for the proper display amplitude. (Use the CHANNEL B VERTICAL POSITION control to align the display with the graticule markings.

7. Disconnect the calibrator signal.

DC Balance Adjustments

After the CA Unit has been in use for a period of time, the trace may change positions as the VARIABLE control is rotated. This is caused by slight changes in the operating characteristics of components in the amplifier stages and resultant shift in operating potentials. To correct this condition proceed as follows:

1. Set the applicable Type CA front-panel controls for both channels as follows:

AC—DC	DC
VOLTS/CM	.05
POLARITY	NORMAL
VERTICAL POSITION	Centered
VARIABLE	CALIBRATED
MODE	A ONLY

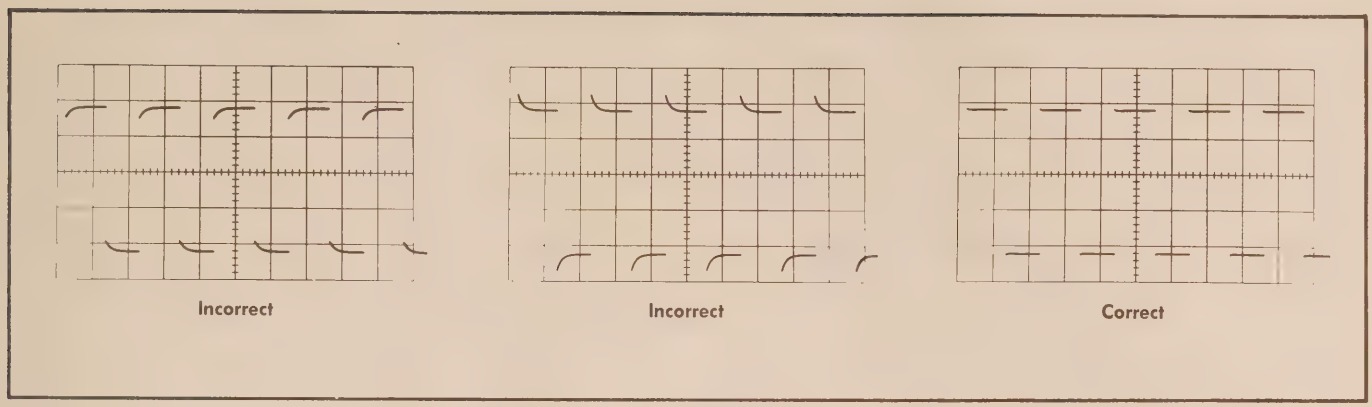


Fig. 2-2. Probe compensation waveforms using a 1 kHz calibrator signal.

2. While rotating the VARIABLE control through its complete range, adjust the DC BAL so that the trace will remain stationary.

3. Set the MODE switch to B ONLY.

4. While rotating the CHANNEL B VARIABLE control through its complete range, adjust the CHANNEL B DC BAL control so that the trace remains stationary.

GENERAL OPERATION

Either of the two preamplifier channels can be used independently by setting the MODE Switch to A ONLY or B ONLY and connecting the signal to be observed to the appropriate input.

Use of Probes

A conventional passive attenuator probe having a standard 42-inch cable lessens both capacitive and resistive loading, but at the same time reduces sensitivity. The attenuation introduced by the probe permits measurement of signal voltages that would overscan the CRT if applied directly to the Type CA. However, in applying high-amplitude signal voltages to either the probe or Type CA, do not exceed their maximum voltage ratings. When making amplitude measurements with an attenuator probe, be sure to multiply the observed amplitude by the probe attenuation.

To assure the accuracy of pulse or high-frequency measurements, check the probe compensation. To make the adjustment, proceed as follows:

1. Set the oscilloscope Amplitude Calibrator for a calibrator output signal of suitable amplitude.

2. Place the MODE switch to the appropriate channel setting (A ONLY or B ONLY) to be used with the probe.

3. Touch the probe tip to the calibrator output connector and adjust the oscilloscope controls to display several cycles of the waveform.

4. Adjust the probe compensation for best square-wave response as shown in the center picture of Fig. 2-2.

NOTE

If a square-wave source other than the oscilloscope calibrator is used for compensating the probe, do not use a repetition rate higher than 5 kHz. At higher repetition rates, the waveform amplitude appears to change as the probe is compensated. Thus, proper compensation is difficult. If the probe remains improperly compensated, transient and frequency response of the system will be poor and measurements will be inaccurate.

Input Coupling

To display both the DC and AC components of an applied signal, set the AC—DC switch to DC. Placing the AC—DC switch in the AC position inserts a capacitor in series with the input so the DC component of the waveform is blocked and only the AC component is displayed. The low-frequency response is about 2 Hz when AC coupling is used.

VOLTS/CM Switch and VARIABLE Control

The amount of vertical deflection produced by a signal is determined by the signal amplitude, the attenuation factor (if any) of the probe, the setting of the VOLTS/CM switch, and the setting of the VARIABLE control. Calibrated deflection factors indicated by the settings of the VOLTS/CM switch apply only when the VARIABLE control is set to the CALIBRATED position. Errors in display measurements may result if the setting of this control is moved away from the CALIBRATED position.

The range of the VARIABLE control is at least 2.5 to 1 to provide continuously variable (uncalibrated) vertical deflection factors between the calibrated settings of the VOLTS/CM switch. When the control is turned to its maximum counterclockwise position and the VOLTS/CM switch is set to 20, the VARIABLE control extends the vertical deflection factor to about 50 volts/cm. By applying the oscilloscope calibrator voltage or any other calibrated voltage source to the Type CA, any specific deflection factor can be set within the range of the VARIABLE control.

Polarity Switch

The POLARITY switch may be used to invert the displayed waveform, particularly when using the dual-trace feature of the Type CA. The POLARITY switch has two positions, NORMAL and INVERTED. In the NORMAL position the displayed waveform will have the same polarity as the applied signal; that is, a positive-going pulse applied to the Type CA will be displayed as a positive-going waveform on the CRT. If a positive voltage is DC coupled to the Type CA, the beam will move up.

In the INVERTED position the displayed waveform will be inverted; that is, a positive-going pulse applied to the Type CA will be inverted and displayed as a negative-going waveform on the CRT. If a positive voltage is DC coupled to the Type CA, the beam will move down.

Mode Switch

The MODE switch has five positions: A ONLY, B ONLY, ALTERNATE, CHOPPED, and ADDED ALGEBRAICALLY. These positions and their purposes are described in the subsequent paragraphs.

A ONLY, B ONLY—Single Trace Operation

To display a single signal (single-trace operation), apply the signal either to the CHANNEL A or CHANNEL B Input connector and set the MODE switch to the corresponding position: A ONLY or B ONLY.

To display a signal in one channel independently when the same signal or a different signal is applied to the other channel, simply select the signal in the channel to be displayed by setting the MODE switch to the appropriate A ONLY or B ONLY position.

ALTERNATE, CHOPPED—Dual-Trace Operation

To display two signals together (dual-trace operation), apply one signal to CHANNEL A Input connector and apply the other signal to the CHANNEL B Input connector. Set the appropriate POLARITY switch to NORMAL or INVERTED depending on whether you want to display the signals in a normal or inverted position, and set the MODE switch to ALTERNATE or CHOPPED.

In general, use the CHOPPED mode of operation with sweep rates up to about .1 msec/cm for displaying two non-repetitive signals occurring within the sweep time interval set by the oscilloscope Time/cm switch. Non-repetitive signals are those signals which are single-shot, transient, or random. The CHOPPED position is also useful for displaying low frequency synchronous signals. Synchronous signals are those which have the same repetition rate or are frequency related by a whole number multiple.

NOTE

When using chopped-mode operation, be sure to set the oscilloscope CRT Cathode Selector switch to the Dual-Trace Chopped Blanking position to blank out the undesirable chopped-mode switching transients.

Use the ALTERNATE position when using sweep rates of about 0.5 msec/cm or faster to display high frequency synchronous and asynchronous signals. Asynchronous signals are those which do not have the same repetition rate or are not frequency related to each other by a whole number multiple.

Displaying Two Non-repetitive or Low Frequency Synchronous Signals

To show true time and phase relationship between two non-repetitive or low frequency (below 10 kHz) synchronous signals, use CHOPPED operation. Transients as short as 1 ms duration can be well delineated or resolved. At .1 msec/cm a 1 ms duration transient, for example, will contain about 100 on segments in its trace. If a higher sweep rate is used, the number of segments that make up each of the traces will be less and therefore resolution will be decreased.

To make the display stable, use external triggering, with the external triggering signal having a definite time relationship to the displayed signals.

Displaying Two Asynchronous Signals

To obtain a stable display of two asynchronous signals which do not exceed the system bandwidth, use ALTERNATE operation and set the oscilloscope Triggering Source switch to Norm Int or Int. Set the oscilloscope Triggering Coupling switch to AC for stable triggering on signals below 10 kHz; set the Triggering Coupling switch to AC LF Reject or AC Fast for stable triggering and a bright display on signals above 10 kHz. Since the oscilloscope vertical amplifier internal trigger is the trigger source, the applied signals will not be displayed in their true time relationship because triggering occurs on the applied signal in each channel as it switches on.

To obtain a stable display in this mode of operation, it is very important to set the oscilloscope Triggering Level control to a point where the time base can trigger on the signal in one channel as it turns on, and on the signal in the other channel when it turns on. In addition, both applied signals must be of sufficient amplitude to meet the internal trigger signal amplitude requirements of the oscilloscope.

If one displayed signal has a smaller amplitude than the other but is of adequate amplitude for internal triggering, then set the Triggering Level control to a point that will assure triggering on the smaller amplitude signal. To do this, set the Triggering Level control near the 0 position.

Though it may seem easy to obtain stable triggering on asynchronous signals, there are certain conditions that may promote jitter. When using the AC Fast or AC LF Reject triggering mode, jitter most likely occurs when attempting to trigger on high-frequency asynchronous signals that are vertically positioned apart on the CRT with POSITION controls. If jitter occurs, it can be reduced and sometimes eliminated by positioning the displays close together or superimposing them. This not only reduces jitter but may also increase the display brightness.

If you use the AC or AC Slow triggering mode, stable internal triggering on asynchronous signals above 1 kHz is more difficult to obtain and the jitter will be greater. If

you are using sweep rates faster than 0.5 msec/cm it is more apparent that the dual-trace display becomes noticeably brighter as the waveforms are vertically positioned together and dimmer when they are positioned apart. These effects are normal and are caused by the problem of triggering on the alternate-mode composite trigger waveform.

The alternate-mode composite trigger consists of the asynchronous signals applied to the Type CA, superimposed on the DC positioning levels of the alternate-mode switching waveform. The switching waveform portion of the composite trigger is a low-frequency square wave whose amplitude is governed by the setting of the POSITION controls and DC components (if any) of the applied signals. Repetition rate of the switching waveform is one half the sweep repetition rate.

When the alternate-mode composite trigger is internally AC coupled to the oscilloscope trigger input circuit, the trigger circuit may not respond instantly to the signals superimposed on the alternate-mode switching signal. The delay is caused by the recovery time of the trigger input circuit as each cycle of the low-frequency switching waveform couples into the input stage of the trigger circuits. Since AC coupling is used in all the Triggering Coupling switch positions (AC, AC Slow, AC Fast, AC LF Reject) recovery time is dependent on the RC time constant of the trigger input circuit.

In conclusion, trigger circuit recovery time is shorter, hence the sweep repetition rate is higher and the display is brighter, if AC Fast or AC LF Reject triggering mode is used. In either of these triggering modes, a smaller value coupling capacitor is used in the oscilloscope trigger input circuit as compared to the value used in the AC or AC Slow triggering mode. Trigger recovery time can be shortened and triggering will be more stable if high-frequency waveform displays are vertically positioned closer together or superimposed rather than positioned further apart.

Added Algebraically

In many applications, the desired signal is superimposed on an undesired signal such as line frequency hum, etc. The Algebraic Output of the Type CA Unit (with the MODE switch in the ADDED ALGEBRAICALLY position) makes it possible in many cases to improve the ratio of desired to undesired signal. To do this, connect one Input to a source containing both the desired and undesired signal. Connect the remaining Input to a source containing only the undesired signal. Place the MODE switch in the ADDED ALGEBRAICALLY position. Set the POLARITY switches to opposite polarities (depending upon the polarity of the desired signal). By careful adjustment, especially at low frequencies, of the VARIABLE control of one of the channels, the undesired displayed signal can be reduced by a factor of 20 compared to the amplitude of the desired signal.

BASIC APPLICATIONS

The following information describes the procedures and techniques for making basic measurements with the Type CA and the associated Tektronix oscilloscope. These applications are not described in detail since each application must be adapted to the requirements of the individual measurements. Familiarity with the Type CA will permit these basic techniques to be applied to a wide variety of uses.

NOTE

All the procedures assume that the Type CA is used with an oscilloscope which provides 6 cm of usable vertical scan. If the Type CA is used with an oscilloscope which provides a usable vertical scan other than 6 cm, interpret the procedures accordingly.

AC Component Voltage Measurements

To measure the AC component of a waveform, the AC-DC switch of the channel you intend to use should be set to the AC position. In this position, only the AC components of the input waveform are displayed on the CRT. (For very low frequency, use the DC position of the switch.)

To make a peak-to-peak voltage measurement of the AC component of a waveform, use the following procedure:

1. Set the VOLTS/CM switch so that the voltage to be applied to the Input connector is not more than about six times the setting.

2. Connect the signal to either Input connector, preferably through a coaxial cable or an attenuator probe.

3. Set the MODE switch to display the channel used.

4. Set the triggering controls to obtain a stable display and set the sweep rate to display several cycles of the waveform.

5. Turn the VERTICAL POSITION control so the lower portion of the waveform coincides with one of the graticule lines below the center line, and the top of the waveform is on the viewing area. With the Horizontal Position control, move the display so one of the upper peaks lies near the vertical center line (see Fig. 2-3).

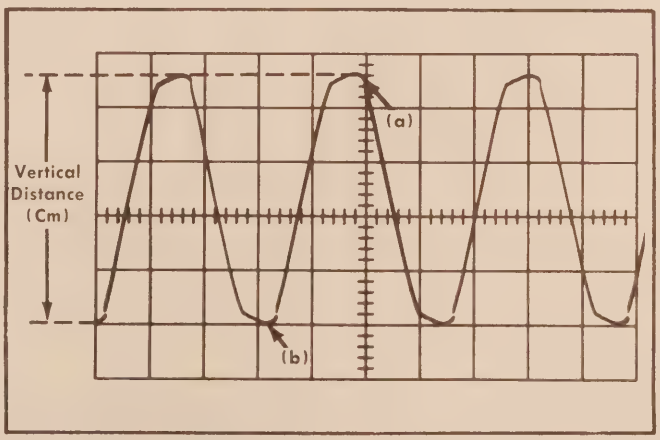


Fig. 2-3. Measuring the peak-to-peak voltage of a waveform.

6. Measure the vertical deflection in centimeters from peak to peak on the waveform. Make sure the VARIABLE control is set to the CALIBRATED position.

NOTE

In measuring signal amplitudes, the width of the trace may be an appreciable part of the overall measurement. To make the measurement as accurate as possible, measure from one side of the trace (particularly when measuring low-amplitude signals). Notice in Fig. 2-3 that points (a) and (b) correspond to the bottom side of the trace. The measurement would be just as accurate if points (a) and (b) correspond to the top, side or center of the trace.

7. Multiply the peak-to-peak distance measured in step 6 by the setting of the CHANNEL A VOLTS/CM switch and the attenuation factor, if any, of the probe.

As an example of this method, assume that the peak-to-peak vertical deflection is 4.6 cm using a 10× probe with the VOLTS/CM switch set to .5. Substituting these values in the following formula:

Volts Peak to peak =

Vertical deflection in cm × VOLTS/CM switch setting × Probe attenuation factor

Then:

Volts Peak to Peak = 4.6 × .5 × 10 = 23 volts

Instantaneous Voltage Measurements

To measure the DC level at a given point on a waveform, proceed as follows:

1. Set the VOLTS/CM switch so that the voltage to be applied to the Input connector is not more than about six times the switch setting.

2. Set the MODE switch to display the channel used.

3. Set the oscilloscope triggering and time base controls so that the time base free runs at the desired rate.

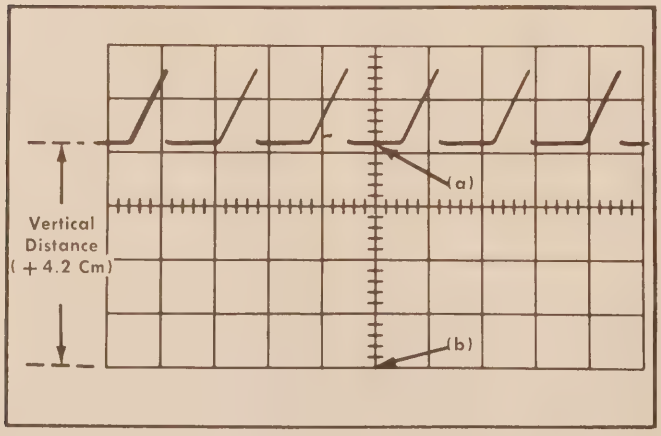


Fig. 2-4. Measuring instantaneous voltage with respect to some reference.

4. Ground the Input connector of the channel to be used and position the trace on one of the horizontal graticule lines such as point (b) in Fig. 2-4. This line will be used as a ground (or zero) reference line. In any case, the reference line chosen will depend upon the polarity and DC level of the signal to be measured. Do not move the VERTICAL POSITION control after the reference line has been established.

NOTE

To measure a voltage level with respect to another voltage rather than ground, make the following changes in step 4. Set the AC-DC switch to DC and apply the reference voltage to the Input connector and position the trace to the reference line.

5. Set the AC-DC switch to DC.

6. Apply the signal, preferably through a coaxial cable or an attenuator probe, to the Input connector.

7. Set the triggering controls of the time base for a stable display.

8. Measure the vertical distance in cm from the ground (zero) reference line established in step 4 to the point on the waveform that you wish to measure, such as between (a) and (b) in Fig. 2-4. If the POLARITY switch is set to NORMAL and the point on the waveform is above the reference line, the polarity is indicated to be positive (+). If the point is below the line, the polarity is negative (—). If the POLARITY switch is set to INVERTED, the indicated polarities will be reversed.

9. Multiply the measured distance by the setting of the VOLTS/CM switch and the attenuation factor, if any, of the probe. This is the instantaneous DC level of the point measured. For example, assume the vertical deflection is 4.2 cm above the reference line (see Fig. 2-4) using a 10× attenuator probe with the POLARITY switch set to NORMAL and the VOLTS/CM switch set to 2. Substitute these values in the following formula:

Instantaneous Voltage (with respect to a ground reference) =

Vertical deflection in cm and polarity × VOLTS/CM switch setting × Probe attenuation factor

Then:

Instantaneous Voltage (with respect to a ground reference) = +4.2 × 2 × 10 = +84 volts

Voltage Comparison Measurements

In some applications you may want to establish a set of deflection factors other than those indicated by the VOLTS/CM switch. This is useful for comparing signals which are exact multiples of a given voltage amplitude. The following procedure describes how to determine deflection factors for CHANNEL A. The same basic procedure

can be used for CHANNEL B. To establish a set of deflection factors based upon some specific reference amplitude, proceed as follows:

1. Apply a known-amplitude reference signal to the CHANNEL A Input connector and adjust the amplitude of the display for an exact number of graticule divisions with the CHANNEL A VOLTS/CM switch and VARIABLE control. Do not move the VARIABLE control after obtaining the desired deflection.

2. Divide the amplitude of the reference signal (in volts) by the product of the deflection in cm (established in step 1) and the VOLTS/CM switch setting. The result is the Deflection Conversion Factor:

$$\text{Deflection Conversion Factor} = \frac{\text{Reference signal amplitude in volts}}{\text{(Deflection in cm) (VOLTS/CM switch setting)}}$$

3. To calculate the True Deflection Factor at any setting of the CHANNEL A VOLTS/CM switch, multiply the VOLTS/CM switch setting by the Deflection Conversion Factor obtained in step 2:

$$\text{True Deflection Factor} = \text{(VOLTS/CM switch setting) (Deflection Conversion Factor)}$$

The True Deflection Factor obtained for any setting of the CHANNEL A VOLTS/CM switch applies to CHANNEL A only, and only if the VARIABLE control is not moved from the position to which it was set in step 1.

For example, assume the amplitude of the reference signal applied to CHANNEL A is 30 volts, the VOLTS/CM switch is set to 5 and the VARIABLE control is adjusted to decrease the amplitude of the display to exactly 4 cm. Then substitute the preceding values in the Deflection Conversion Factor and True Deflection Factor formulas:

$$\text{Deflection Conversion Factor} = \frac{30}{(4)\ (5)} = 1.5$$

$$\text{True Deflection Factor} = (5)\ (1.5) = 7.5 \text{ volts/cm}$$

4. To determine the peak-to-peak amplitude of a signal to be compared, disconnect the reference signal and apply the signal to CHANNEL A.

5. Set the CHANNEL A VOLTS/CM switch to a setting that will provide enough deflection so that a measurement can be made.

6. Measure the vertical distance in cm and determine the amplitude by using the following formula:

$$\text{Signal Amplitude} = \text{Deflection Conversion Factor} \times \text{Deflection in cm} \times \text{VOLTS/CM setting switch}$$

For example, assume the signal to be compared caused a vertical deflection of 4.5 cm at a VOLTS/CM switch setting of 10 and the VARIABLE control was not moved from the setting used in the previous example. Then, substitute these values and a Deflection Conversion Factor of 1.2 in the Signal Amplitude formula:

$$\text{Signal Amplitude (in volts)} = (1.5)\ (4.5)\ (10) = 67.5 \text{ volts}$$

Time-Difference Measurements

The calibrated sweep rate of the oscilloscope and the dual-trace feature of the Type CA allow measurement of the time difference between events. Measure time difference as follows:

1. Set the AC-DC switches to identical settings; either AC or DC depending on the type of coupling desired.

2. Set the POLARITY switches to NORMAL.

3. Set the VOLTS/CM switches so that the expected voltages applied to the Input connectors will provide suitable vertical deflection on the CRT.

4. Place the MODE switch to either CHOPPED or ALTERNATE, as desired. In general, the CHOPPED position is more suitable for low-frequency signals.

5. Apply the reference signal to CHANNEL A and the signal to be compared to CHANNEL B. Use coaxial cables or probes having equal delay.

6. Set the oscilloscope Trigger Slope switch to externally trigger on the reference signal. Use a T connector at the Input of CHANNEL A for trigger signal to apply at the Trigger Input connector.

NOTE

Trigger requirements of the oscilloscope make it necessary that the trigger signal be at least .2 volts in amplitude.

7. Set the oscilloscope time-base controls for a calibrated sweep rate which will allow accurate measurement of the distance between the two waveforms.

8. Measure the horizontal distance between the reference waveform and the CHANNEL B waveform (see Fig. 2-5).

9. Multiply the distance measured for each channel by the setting of the oscilloscope Time/cm switch to obtain the apparent time interval.

10. To obtain the actual time interval, divide the apparent time interval by the amount of sweep magnification, if sweep magnification is used, and by 1 if no sweep magnification is used. The formula is as follows:

$$\text{Time Delay} = \frac{\text{(Time/cm switch setting) (Distance in cm)}}{\text{Sweep Magnification}}$$

For example, assume that the Time/cm switch setting is 2 μsec, the Magnifier is set for 5$\times$ magnification, and there is a horizontal distance of 3 cm (as shown in Fig. 2-5) between the leading edge of the reference waveform and the leading edge of the waveform displayed by CHANNEL B. Then substitute these values in the preceding formula:

$$\text{Time Delay} = \frac{(2\ \mu\text{sec})\ (3\text{ cm})}{5} = 1.2\ \mu\text{s}$$

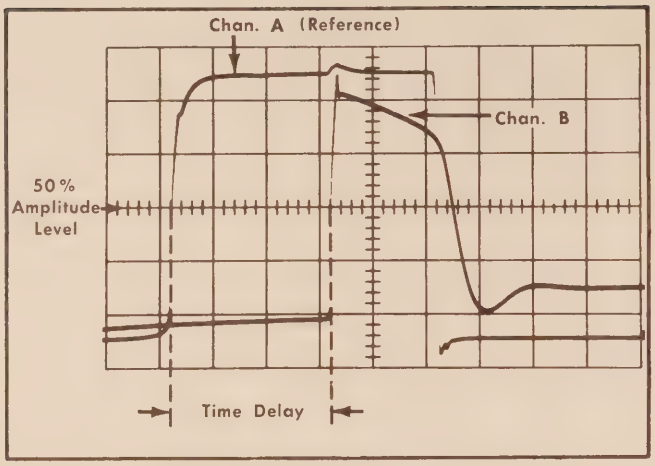


Fig. 2-5. Measuring time delay between pulse waveforms.

Phase Measurements

Phase comparison of two signals of the same frequency can be made using the dual-trace feature of the Type CA. To make the comparison, proceed as follows:

1. Follow the procedure outlined in the first six steps under Time-Difference Measurements.

2. Set the oscilloscope sweep rate to obtain a display of less than 1 cycle of the waveform.

3. Adjust the VARIABLE control for each channel so the waveform amplitudes are equal and fill the graticule area vertically. Reset the VOLTS/CM switches, if necessary, to obtain equal-amplitude waveform displays. (Equal amplitudes are used to make comparisons easier.)

4. Use the POSITION controls to center the waveforms vertically; that is, an equal distance each side of the graticule center line.

5. Turn the oscilloscope Variable Time/Cm control counterclockwise until 1 cycle of the reference signal occupies 9 cm horizontally. Use the Trigger Slope and Triggering Level controls to trigger on the reference waveform at any point you desire. Each cm on the graticule now represents 40° of 1 cycle (see Fig. 2-6).

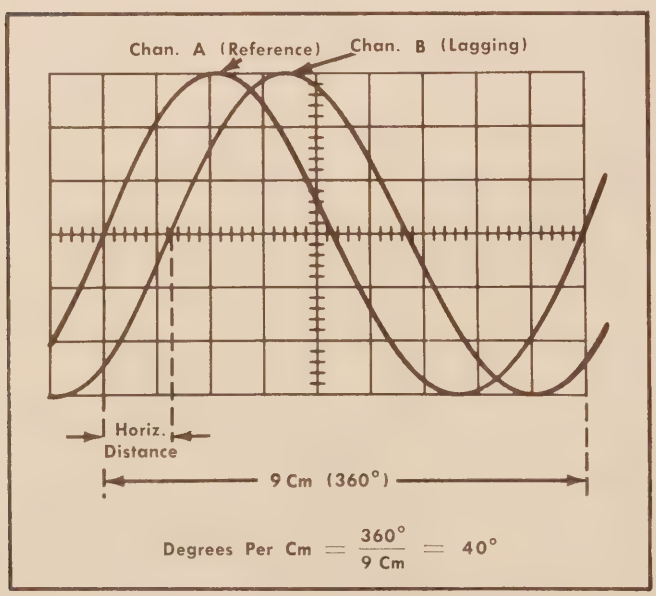


Fig. 2-6. Measuring phase shift between electrical waveforms.

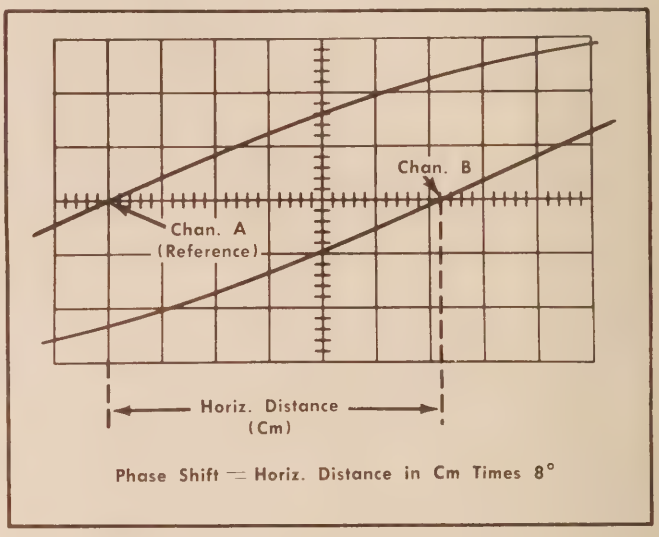


Fig. 2-7. Computing the phase shift when the oscilloscope sweep rate is increased 5X.

6. Measure the horizontal distance, in cm, between corresponding points on the waveforms. Note the distance and whether the CHANNEL B waveform is leading or lagging (see Fig. 2-6).

7. Multiply the distance by 40°/cm to obtain the amount of phase difference.

For more precise measurements, increase the previous sweep rate but do not change the setting of the oscilloscope Variable Time/Cm control. However, you must consider this increase in your calculations.

For example, if you increase the sweep rate by a factor of 5, and then measure the distance between waveforms, each cm will represent 8° (40° ÷ 5) of a cycle. Thus, phase difference up to 80° can be measured more accurately. When preparing to make the measurement, horizontally position the waveforms to points where the graticule markings aid in determining the exact distance. Fig. 2-7, for example, shows how the phase difference of the CHANNEL B waveform can be computed using this method.

SECTION 3

CIRCUIT DESCRIPTION

Introduction

The Type CA Dual-Trace Plug-In Unit consists of two identical amplifier channels, a channel switching multivibrator and an output cathode follower. The following description of the CHANNEL A preamplifier applies equally well to the CHANNEL B preamplifier.

Input Coupling

The signal to be displayed is applied to the Input Cathode Follower V3323 by way of the AC-DC switch SW3300 and the VOLTS/CM switch SW3310. In the DC position of the AC-DC switch, the input coupling capacitor C3300 is bypassed so the input is DC coupled. In the AC position, the signal must pass through C3300, which blocks the DC component. C3300 limits the low frequency response to about 2 Hz at —3 dB.

Input Attenuation

The VOLTS/CM switch SW3310 is a 9-position rotary switch which contains the attenuator networks and is electrically connected in the grid circuit of the input cathode follower, V3323. The deflection factor of the unit is .05 volts/cm. At the .05 setting of the VOLTS/CM switch, the signal is coupled without attenuation to the input cathode follower, V3323.

In the remaining positions of the VOLTS/CM switch (.1 through 20) individual attenuator networks are switched into the grid circuit of the input cathode follower. These attenuator networks are frequency-compensated RC voltage dividers which change the indicated deflection factor to the basic .05 volts/cm of the plug-in unit at the grid of V3323.

The attenuation factor of the networks can generally be expressed as follows:

$$\text{Attenuation Factor} = \frac{\text{total divider resistance (including R3320)}}{\text{grounded-leg resistances (including R3320)}}$$

Using the ×4 attenuator as a specific example the formula is:

$$\text{Attenuation Factor} = \frac{(R3312C)(R3312E) + (R3312C)(R3320) + (R3312E)(R3320)}{(R3312E)(R3320)} = 4$$

At low frequencies the dividers are resistive because the impedance of the capacitors is high and their effect in the circuit is negligible. As the frequency of the input signal increases, the impedance of the capacitors decreases and their effect in the circuit becomes more pronounced.

For high-frequency signals, the impedance of the capacitor is low in comparison to the resistance of the circuit and the attenuators become capacitive voltage dividers. For these frequencies, the attenuation factor is similar to the resistance condition, except that the capacitive reactances are the dominant factors involved. A variable capacitor in each attenuator, such as C3321C in the X4 attenuator, provides a method for adjusting the capacitive reactance ratios equal to the resistance ratios.

The variable capacitor at the input to the ×2 through ×400 attenuation network provides a means of adjusting the input RC of the attenuator to an arbitrary standard value of 20 pF × 1 MΩ when using a 20 pF Input RC Standardizer as a reference. Similarly, C3322 provides a method for standardizing the input time constant when the VOLTS/CM switch is set at .05. In addition to providing the same input capacitance, the resistance values of the attenuators are chosen to provide an input resistance of 1 megohm for each setting of the VOLTS/CM switch. Thus an attenuator probe, when connected to the Input connector of the Type CA, will work into the same time constant regardless of the setting of the VOLTS/CM switch.

Input Cathode Follower V3323

The Input Cathode Follower stage presents a high-impedance, low-capacitance load to the input circuit and isolates the input circuit from the succeeding stages. The cathode is connected through R3324 to the —150 volt supply. The large value of R3324 permits the stage to operate linearly.

Input Amplifiers V3334 and V3354

The Input Amplifier stage is a cathode-coupled paraphase amplifier. The control-grid DC level of V3334 is established by the DC connection to the cathode of V3323. The control-grid level of V3354 is adjusted by the DC BAL control so that the DC level of the cathodes of V3334 and V3354 can be made equal. Any DC level difference between these two cathodes would act as a signal and cause the trace to shift position when the VARIABLE control is rotated. The VARIABLE control establishes the amount of cathode coupling between V3334 and V3354 and thus allows the stage gain to be varied over an approximate 2.5 to 1 range.

The GAIN ADJ control varies the current through the Input Amplifiers by changing the cathode resistance, thus varying the G_m of the two amplifiers so that the basic gain of the unit can be accurately set to agree with the front-panel calibration.

The output signal of V3334 is out of phase with the input signal, and the output signal of V3354 is in phase with the input signal.

Polarity and Positioning

Setting the POLARITY switch in the NORMAL position sets the output at pin 1 of the interconnecting plug of the Plug-In Unit in phase with the input signal. In the INVERTED position, the signal path to the control grids of the output amplifiers is changed and the output signal is inverted.

The VERTICAL POSITION control R3361 connected between the control grids of the push-pull output amplifier, provides the DC level shift which acts as positioning signal super-imposed on the output signals of the input amplifier stage. The DC level shift moves the trace vertically.

Output Amplifiers V3364 and V3374

The Output Amplifier stage is a push-pull amplifier. A common plate load is shared by V3364 and V4364 (Channel B Output Amplifier Stage). This common load provides the mixing of the Channel A and the Channel B signals when the MODE switch is in the ADDED ALGEBRAICALLY position. V3374 and V4374 also share a common load for this purpose. In the other position of the MODE switch, the common load effect is negligible, as one amplifier is always cut off while the other is conducting.

Output Cathode Follower

V4383 is the Output Cathode Follower that provides a low-impedance source for driving the oscilloscope vertical amplifier. The Vert. Pos. Range control located in the grid circuit of the Output Cathode Followers permits the trace to be centered vertically under no-signal conditions.

Switching Circuit

The switching circuit consists of a Switching Multivibrator a Trigger Coupling Diode, a Shaper and Switching Cathode Followers. The circuits are arranged in various configurations by the MODE switch SW3380. The operation of the switching circuit and its effect on the channel operation at the different settings of the MODE switch is described in the following paragraphs. See the schematic diagram in Section 9 of this manual for the appropriate voltages.

A ONLY. This position of the MODE switch allows only the CHANNEL A signal to pass to the Output Amplifier. The grid of V3375A is held positive and this half of the multivibrator conducts while the grid of V3375B is held negative and the tube is cut off.

The conduction of V3375A holds the cathode voltage above ground, causing V3384B to conduct and pull the grid of V3393B toward ground. This in turn lowers the plate voltage of V4334 and V4354. This reduced plate voltage cuts off V4364 and V4374, and the CHANNEL B amplifier is held in a non-conducting state.

With V3375B cut off, the grid of V3384A is near ground potential with resultant reduced plate current. Therefore, the plate of V3384A and the grid of V3393A become more positive, providing plate voltage for V3334 and V3354. The CHANNEL A amplifier is in a state of conduction.

B ONLY. In this position of the MODE switch only the CHANNEL B signal passes to the Output Amplifier. This is done by reversing the state of the Switching Multivibrator from the condition of the A ONLY position. That is, V3375A is cut off and V3375B is conducting. The CHANNEL B amplifier is in a state of conduction and the CHANNEL A amplifier is held in a non-conducting state.

ALTERNATE. In the ALTERNATE position of the MODE switch, the switching circuit must switch to the opposite Channel at the end of each sweep of a time-base circuit. In this configuration, both grids of the Switching Multivibrator, V3375, are returned to ground. It is then a bistable multivibrator. At the end of each sweep cycle, a negative-going trigger is generated by the time-base circuit. This trigger arrives at the cathodes of the trigger coupling diode, V3382, from pin 16 of the interconnecting plug, causing the multivibrator to switch from one stable condition to the other. This alternately switches the amplifiers on and off. The switching rate is determined by the repetition rate of the sweep.

When the Type CA Unit is used with an oscilloscope that has alternate sweep switching, an Alternate Sweep Slave Pulse is coupled into pin 7 of the interconnecting plug. The oscilloscope Horizontal Display switch must be in the Alt (A and B) position. The slave pulse ensures that the Switching Multivibrator, V3375, turns CHANNEL A on during the Time Base A sweep of the oscilloscope, which allows the CHANNEL A signal to be displayed on the Time Base A sweep. During the time that Time Base B is generating its sweep, the same generator also produces a negative-going (+45 volts to ground) slave pulse. The slave pulse prevents conduction by V3375A and the A channel is held in a non-conducting state while Time Base B is generating its sweep.

CHOPPED. In this position of the MODE switch, both grids of the Switching Multivibrator are returned to a positive voltage. Incoming triggers have no effect on the operation as the Switching Multivibrator is free-running at approximately 100 kHz, determined by the time constant of the grid circuits. The two amplifiers are alternately cut off and allowed to conduct at the free-running rate of the multivibrator. A blanking signal is coupled from the plates of the multivibrator through C3375 and C3385 to pin 16 of the interconnecting plug. This blanking signal blanks the electron beam of the oscilloscope while the Switching Multivibrator switches between channel amplifiers.

ADDED ALGEBRAICALLY. This position of the MODE switch permits the output of both Channels to pass to the Output Amplifier at the same time. Both grids of the Switching Multivibrator are returned to a negative voltage so the incoming triggers have no effect on the multivibrator grids. Both cathodes of the multivibrator V3375 are down, causing both Shapers, V3384A and V3384B, to be cut off. This raises the plate voltage of the shapers and the grid voltage of the following stages, Cathode Followers V3393A and V3393B. The cathodes of V3393A and V3393B are up and both Channel amplifiers are in a state of conduction.

NOTE

Plate voltage for the Input Amplifier stages of both channels is supplied by the cathodes of V3393A and V3393B.

Under the conditions described above, signals applied to both inputs will be amplified equally by either channel. Algebraic addition of the signal occurs at the grids of the output stage, V4383. In phase input signals add, and out of phase input signals subtract at the grid of each tube if the polarity switches are at the same setting.

SECTION 4

MAINTENANCE

PREVENTIVE MAINTENANCE

Cleaning the Interior

To clean the interior of the Type CA, blow off the accumulated dust using low-velocity compressed air. A very high velocity air stream should be avoided, however, to prevent damage to some of the components.

Visual Inspection

Many potential or existing troubles can be detected by a visual inspection of the unit. For this reason, a complete visual check should be performed every time the instrument is recalibrated or repaired. Visual defects may include loose or broken connections, damaged connectors, improperly seated tubes, scorched or burned parts and broken terminal strips.

The remedy for these troubles is readily apparent except in the case of heat-damaged parts. Damage to parts due to heat is often the result of other, less apparent troubles in the circuit. It is essential that the cause of overheating be determined and corrected before replacing the damaged parts to prevent damage to the new components.

Checking Tubes

Periodic tester checks on the tubes used in the Type CA are not recommended. Tube testers, in many cases, indicate a defect when a component is operating satisfactorily in a circuit, and fail to indicate defects which affect circuit performance.

The true test of tube usability is whether or not the tube works properly in the circuit. If it is working correctly, it should not be replaced.

Calibration

The Type CA should provide many hours of trouble-free operation. However, to insure the reliability of measurements, check the calibration of the unit after each 500-hour period of operation (or every six months if the unit is used intermittently). A complete step-by-step procedure for recalibrating the unit and checking its operation is given in the Calibration section of this manual.

CORRECTIVE MAINTENANCE

Soldering and Ceramic Strips

Special silver-bearing solder is used to establish a bond to the ceramic terminal strips in Tektronix instruments. This bond can be broken by repeated soldering (especially if ordinary tin-lead solder is used) or by excessive heating. Solder containing about 3% silver is recommended. Silver-bearing solder can usually be purchased locally or through your Tektronix Field Engineer or Field Office—specify Tektronix Part No. 251-0514-00.

The following procedure is recommended when soldering to ceramic terminal strips:

1. Use a wedge-shaped soldering-iron tip about 1/8 inch wide. This allows heat to be applied directly to the solder in the terminal strip, thereby reducing the amount of heat required.

2. Maintain a clean, properly tinned tip.

3. Use a hot iron for a short time. A 50- to 75-watt iron having a good heat transfer and storage characteristics is adequate.

4. Avoid putting pressure on the strip. Excess pressure may crack or chip the strip.

5. Apply only enough heat to make the solder flow freely.

6. Do not attempt to fill the notch on the strip with solder; instead apply only enough solder to cover the wires adequately and establish a solid solder joint. Over-filling the notches may result in cracked terminal strips. If the lead extends beyond the solder joint, clip the excess as close to the joint as possible. Remove all wire clippings from the chassis.

In soldering to metal terminals (for example, pins on a tube socket) a slightly different technique should be employed. Prepare the iron as outlined above, but tin with ordinary tin-lead solder. The procedure for soldering is as follows:

1. Apply only enough heat to melt the solder and remove the lead.

2. When resoldering the lead, apply enough heat to make the solder flow freely.

3. If the lead extends beyond the solder joint, clip the excess close to the solder joint.

Soldering to terminal pins mounted in plastic rods (such as the plastic coil form) make it necessary to use some form of heat sink to avoid melting the plastic. A pair of long-nosed pliers makes a convenient tool for this purpose.

Ceramic Terminal Strips

Fig. 4-1 shows an assembled ceramic terminal strip. Replacement strips with studs attached are supplied under one part number; the spacers are supplied under a separate part number. However, the old spacers may be re-used if not damaged.

Usually a strip can be pried out of the chassis or pulled out with a pair of pliers. If desired, a hammer and punch may be used to drive out the studs from the opposite side of the chassis.

When the damaged strip has been removed, place the new or used but undamaged spacers in the chassis holes. Then, carefully force the studs of the new strip into the spacers until they are completely seated. If necessary, use a soft-faced mallet and tap lightly, directly over the stud area of the strip.

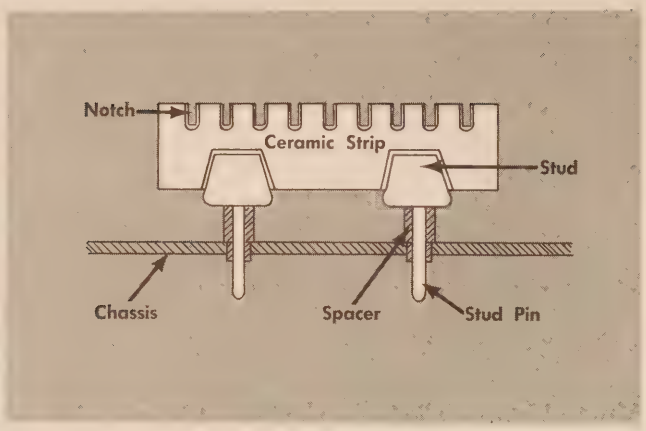


Fig. 4-1. Ceramic strip assembly.

Switches

Methods for removal of defective switches are, for the most part, obvious and only a normal amount of care is required. Single wafers are normally not replaced on the switches used in the Type CA Unit, and if one wafer is defective, the entire switch should be replaced. Switches may be ordered from Tektronix either wired or unwired as desired.

When soldering a switch assembly, do not let the solder flow around and beyond the terminal rivet since this may destroy the spring tension of the contact.

Component Replacement

Certain parts in the instrument are easiest to replace by following a definite procedure. The procedures for replacing these parts are outlined in the following paragraphs.

Many electrical components are mounted in a particular manner to reduce or control stray capacitance or inductance. Duplicate the original location and mounting when replacing components. When selecting replacement parts, remember that the physical nature of a component can affect its performance at high frequencies. After repair, check the instrument calibration.

Standard Parts

Many of the components in this instrument are standard electronic parts that can be purchased locally. However, all parts in the instrument can be obtained through your Tektronix Field Engineer or Field Office. Before purchasing or ordering parts, check the parts list to determine the value, tolerance, and rating required.

Special Parts

Some of the parts in the instrument are manufactured or selected by Tektronix to meet specific requirements, or are manufactured for Tektronix to our specifications. These parts and most mechanical parts should be ordered through your Tektronix Field Engineer or Field Office. See Parts Ordering Information and Special Notes and Symbols.

TROUBLESHOOTING AIDS

Schematic Diagrams

Circuit diagrams are contained in the pull-out pages of Section 9. The circuit diagrams contain component circuit numbers and operating voltages to be found at key points. Conditions under which the voltages were taken are also indicated on the diagrams.

Switch Wafer Identification

Switch wafers shown on the diagrams are coded to indicate the position of the wafer in the complete switch assembly. The numbered portion of the code refers to the wafer number counting from the front, or mounting end of the switch, toward the rear. The letters F and R indicate whether the front or rear of the wafer performs the particular switching function. For example, a wafer designated 2R indicates that the rear of the second wafer is used for this particular switching function.

Cable Color Coding

All wiring in the Type CA Unit is color coded to facilitate circuit tracing. The power-supply wires originating at the oscilloscope interconnecting plug are identified by the following code; the widest stripe identifies the first color in the code.

Supply Voltage	Cable Color Code
+350 V	Orange-green-brown on white background
+225 V	Red-red-brown on white background
+100 V	Brown-black-brown on white background
—150 V	Brown-green-brown

Interconnecting-Plug Resistance Checks

Table 4-1 lists the approximate resistance measured between the interconnecting-plug pins and ground of the 16-pin plug located on the rear panel of the Type CA. These measurements were taken with the Type CA disconnected from the associated oscilloscope. The measurements are particularly useful for locating a possible short circuit or low-resistance path in the unit, if such trouble should occur.

TABLE 4-1

Nominal Resistance at Interconnecting Plug

Pin Number	Resistance to Ground
1	8.5 kΩ
2	0
3	8.5 kΩ
4	infinite
5	infinite
6	infinite
7	infinite
8	0 (Mode switch at ALTERNATE)
9	12 kΩ
10	2 kΩ
11	6.3 kΩ
12	infinite
13	infinite
14	infinite
15	65 Ω
16	320 kΩ[1]

[1]infinite below Serial Number 34790

SECTION 5

PERFORMANCE CHECK

Introduction

This section of the manual provides a means of rapidly checking the performance of the Type CA. It is intended to check the calibration of the instrument without the need for performing the complete Calibration Procedure. The Performance Check does not provide for the adjustment of any internal controls. Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments, and the user should refer to the Calibration Procedure in this manual.

Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment is assumed to be calibrated and operating within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For the most accurate and convenient performance check, special calibration fixtures are used in this procedure. These calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Calibrated Tektronix 540 Series convertible oscilloscope or equivalent. (Type 547 to check the Alternate Slave sweep operation.)

2. Standard amplitude calibrator. Amplitude accuracy, 0.25%; signal amplitude, 5 millivolts to 100 volts peak to peak; output signal, 1 kHz. Tektronix calibration fixture 067-0502-00 recommended.

NOTE

An amplitude calibrator of 1% or better accuracy must be used to check and/or set the deflection factor of the Type CA to an accuracy of ±3%. If the calibrator of the oscilloscope (item 1) is used, accuracy of the plug-in unit will be ±6%. If an accuracy of ±6% is sufficient, use the calibrator of the oscilloscope instead of item 2.

3. Square-wave generator. Frequency, 1 kHz; risetime, 13 ns or less into a 50-ohm cable terminated at both ends; output amplitude variable from 10 to 100 volts across a 600-ohm load. Tektronix Type 106 or Type 105 Square-Wave Generator recommended.

4. Square-wave generator. Frequency, about 450 kHz; risetime, less than 3 ns into a terminated 50-ohm cable; output voltage, 0.1 to 0.5 volts terminated in 50 ohms. Tektronix Type 106 or Type 107 Square-Wave Generator recommended.

5. Constant amplitude signal generator. Frequency, 50 kHz and 350 kHz to 30 MHz; amplitude accuracy, ±2%. Tektronix Type 191 or Type 190B recommended.

6. 20 pF Input RC Standardizer. Tektronix Part No. 011-0066-00 if CA inputs are BNC; Tektronix Part No. 011-0022-00 if CA inputs are UHF.

7. 50 ohm Termination resistor, Tektronix Part No. 011-0049-00 BNC, 011-0045-00 UHF.

8. 50 ohm coaxial cable, 42 inches long. Tektronix Part No. 012-0057-00 BNC connectors; 012-0001-00 UHF connectors.

9. Patch cord with banana plug and BNC connector; length 18 inches. Tektronix Part No. 012-0090-00.

10. CA Dual Input Connector, Tektronix calibration fixture 067-0525-00 with BNC connectors; Tektronix Part No. 003-0035-00 with UHF connectors.

11. Adapter. Connectors, GR to BNC jack. Tektronix Part No. 017-0063-00.

12. Small shank screwdriver.

PERFORMANCE CHECK PROCEDURE

General

In the following procedure, test equipment connections or control settings should not be changed except as noted. If only a partial check is desired, refer to the preceding step(s) for setup information.

The following procedure uses the equipment listed under Recommended Equipment. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

a. Connect the power cord of the oscilloscope to the design-center operating voltage for which the oscilloscope is wired.

b. Install the Type CA Unit in the oscilloscope.

c. Turn on all test equipment and allow 15 minutes for warm-up and stabilization.

d. Set the following instrument controls.

Type CA

CHANNELS A & B	
AC-DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED (detent)
POLARITY	NORMAL
VERTICAL POSITION	Centered
MODE	A ONLY

Test Oscilloscope

Some of the Tektronix oscilloscopes with which a Type CA may be used have both a Time-Base A and a Time-

Base B. Control settings listed below apply to the Main Time Base on these oscilloscopes. That is, Time Base A on all except Types 546 and 547, where Time Base B is the Main Time Base.

Stability	Full clockwise
Triggering Level	Full clockwise
Triggering Mode	Auto
Trigger Slope	Int— (minus)
Time/cm	1 msec
Variable Time/cm	Calibrated
5X Magnifier	Off
Horizontal Display	A or Normal
CRT Cathode Selector	Ext CRT Cathode
Amplitude Calibrator	Off
Horizontal Position	Centered
Focus, Astigmatism and Intensity	For a well defined trace, (It may be necessary to adjust the POSITION controls to center the trace.)
Scale Illum	User's preference

NOTE

Do not change any control settings until instructed to do so.

1. Check Polarity Balance, Both Channels

a. Requirement—Trace shift due to changing the POLARITY switch from NORMAL to INVERTED less than ±1.5 cm with a slow drift less than ±2 mm.

b. Rotate the CHANNEL A VARIABLE control and check for vertical trace movement.

c. Adjust the CHANNEL A DC BAL control with a screwdriver until there is no trace movement.

d. Set the VARIABLE control in the CALIBRATED (detent) position.

e. Center the trace with the CHANNEL A VERTICAL POSITION control.

f. Change the POLARITY switch from NORMAL to INVERTED.

g. Check—Trace shift less than ±1.5 cm with a slow drift less than ±2 mm. (Ignore rapid or spurious movements.)

h. Return the POLARITY switch to NORMAL.

i. Set the MODE switch to B ONLY.

j. Repeat the procedure to check CHANNEL B.

2. Check Grid Current and Microphonics, Both Channels

This is a check on operating performance, not a check of a particular characteristic.

a. Requirement—Trace shift due to changing the AC-DC switch to AC less than ±3 mm; microphonics due to rotation of the VOLTS/CM switch less than 2 mm.

b. Ground the CHANNEL B Input using a patch cord.

c. Change the AC-DC switch to AC.

d. Check—Trace shift less than ±3 mm.

e. Return the AC-DC switch to the DC position.

f. Rotate the VOLTS/CM switch.

g. Check—Microphonics less than 2 mm.

h. Return the VOLTS/CM switch to .05.

i. Set the MODE switch to A ONLY.

j. Ground the CHANNEL A Input using a patch cord.

k. Repeat the procedure for CHANNEL A.

l. Remove the input grounding lead.

3. Check VERTICAL POSITION Controls

a. Requirements—Traces within 3 cm of each other and within 2 cm of graticule center with both VERTICAL POSITION controls centered. Trace not more than 2 cm from the center graticule line in ADDED ALGEBRAICALLY.

b. Set the MODE switch to ALTERNATE.

c. Set both CHANNEL A and B VERTICAL POSITION controls to the center of rotation (dot straight up).

d. Check—Traces should be within 3 cm of each other and within 2 cm of the graticule center.

e. Position both traces to the center graticule line.

f. Set the MODE switch to ADDED ALGEBRAICALLY.

g. Check—Trace position no more than 2 cm from the center graticule line.

h. Set the MODE switch to A ONLY.

4. Check GAIN ADJ Range, Both Channels

a. Requirement—At least ±5% range (2.1 to 1.9 cm).

b. Apply .1 V from the Standard Amplitude Calibrator to the CHANNEL A Input.

c. Rotate the CHANNEL A GAIN ADJ control with screwdriver fully clockwise.

d. Check—Amplitude at least 2.1 cm.

e. Rotate the GAIN ADJ control fully counterclockwise.

f. Check—Amplitude no more than 1.9 cm.

g. Set GAIN ADJ for exactly 2 cm of deflection.

h. Repeat the procedure for CHANNEL B.

5. Check Deflection Accuracy of VOLTS/CM Switch, Both Channels

a. Requirement—Vertical deflection within ±3% of the VOLTS/CM switch indication.

b. Change the settings of the VOLTS/CM switch and output of the Standard Amplitude Calibrator using Table 5-1.

c. Check—Using Table 5-1, the vertical deflection within ±3% in each position of the CHANNEL B VOLTS/CM switch.

d. Repeat the procedure for CHANNEL A.

6. Check VARIABLE CONTROL Range, Both Channels

a. Requirement—Attenuation ratio at least 2.5:1.

b. Set the CHANNEL A VOLTS/CM switch to 20 V/cm.

c. Set the Standard Amplitude Calibrator for 50 V output.

d. Rotate the VARIABLE control counterclockwise for full attenuation.

e. Check—Maximum deflection of 1 cm, an attenuation ratio of 2.5:1. The VARIABLE control is continuously variable from .05 V/cm to 50 V/cm.

f. Repeat the procedure for CHANNEL B.

TABLE 5-1

VOLTS/CM Switch Setting	Standard Amplitude Calibrator Output	Vertical Deflection In Centimeters	Maximum Error For 3% Accuracy In Millimeters
.05	.1 V	2	Adjusted
.1	.2 V	2	±.6
.2	.5 V	2.5	±.75
.5	1 V	2	±.6
1	2 V	2	±.6
2	5 V	2.5	±.75
5	10 V	2	±.6
10	20 V	2	±.6
20	50 V	2.5	±.75

g. Set both VOLTS/CM switches to .05.

h. Set the Standard Amplitude Calibrator output to .1 V.

7. Check AC-DC Switch Operation, Both Channels

a. Requirement—Correct signal coupling in each position.

b. Apply a .1 V Standard Amplitude Calibrator signal to the CHANNEL B Input.

c. Position the bottom line of the display on the center graticule line.

d. Set the AC-DC switch to AC.

e. Check—Wavefrom shift downward 1 cm ±2 mm.

f. Remove the Standard Amplitude Calibrator signal.

g. Repeat the procedure for CHANNEL A.

8. Check Alternate Mode Operation

a. Requirement—Trace alternation on all sweep rates between .1 μsec and 5 sec.

b. Set the MODE switch to ALTERNATE.

c. Position the traces 2 cm apart with VERTICAL POSITION controls.

d. Change the oscilloscope Time/cm switch to .1 μsec and the Triggering Mode to AC.

e. Check—Alternate traces at all Time/cm settings (alternation between A and B). Wait for 1 complete alternation before proceeding. At slower sweep rates, turn the Intensity control counterclockwise to avoid possible damage to the CRT phosphor.

9. Check Chopped Mode Operation

a. Requirement—Chopped repetition rate, 100 kHz ± 30%. Blanking of switching transients. Symmetry ratio 3:2 or 2:3 maximum. Distortion 1 mm maximum.

b. Set the MODE switch to CHOPPED.

c. Set the oscilloscope Time/cm switch to 10 μsec, Triggering Mode to Auto and turn the Intensity clockwise for normal trace brightness.

d. Check—Duration of one complete cycle between .7 and 1.3 cm, which is 100 kHz ± 30%.

e. Compare length of the top and bottom lines of the display.

f. Check—Symmetry ratio 3:2 or 2.3 maximum.

g. Set the oscilloscope CRT Cathode Selector switch, at the rear of the oscilloscope, to Dual Trace Chopped Blanking.

h. Check—Rising and falling portions of the chopped waveform are blanked (not visible). It may be necessary to reduce intensity to observe the blanking.

i. Change the oscilloscope Time/cm to 1 μsec.

j. Check—Distortion of the flat top of the waveform no more than 1 mm.

k. Return oscilloscope CRT Cathode Selector to External CRT Cathode and Time/cm switch to 1 msec.

10. Check Added Algebraically Mode Operation

a. Requirement—Signal addition; rejection ratio 20:1.

b. Set the MODE switch to ADDED ALGEBRAICALLY.

c. Apply .1 V Standard Amplitude Calibrator signal to both Input connectors through the CA Dual Input Assembly.

d. Check—CRT display 4 cm of deflection, ± 3%.

e. Change the CHANNEL A (or B) POLARITY switch to INVERTED.

f. Change the Standard Amplitude Calibrator to 1 volt.

g. Check—Trace amplitude no more than 1 cm, rejection ratio 20:1.

h. Set POLARITY switches to NORMAL.

i. Set MODE switch to A ONLY.

j. Remove the Standard Amplitude Calibrator signal.

k. Set oscilloscope Time/cm switch to .5 msec.

11. Check Input Time Constant and Volts/cm Compensations, Both Channels

a. Requirement—Flat top waveform with not more than 4% rolloff or overshoot.

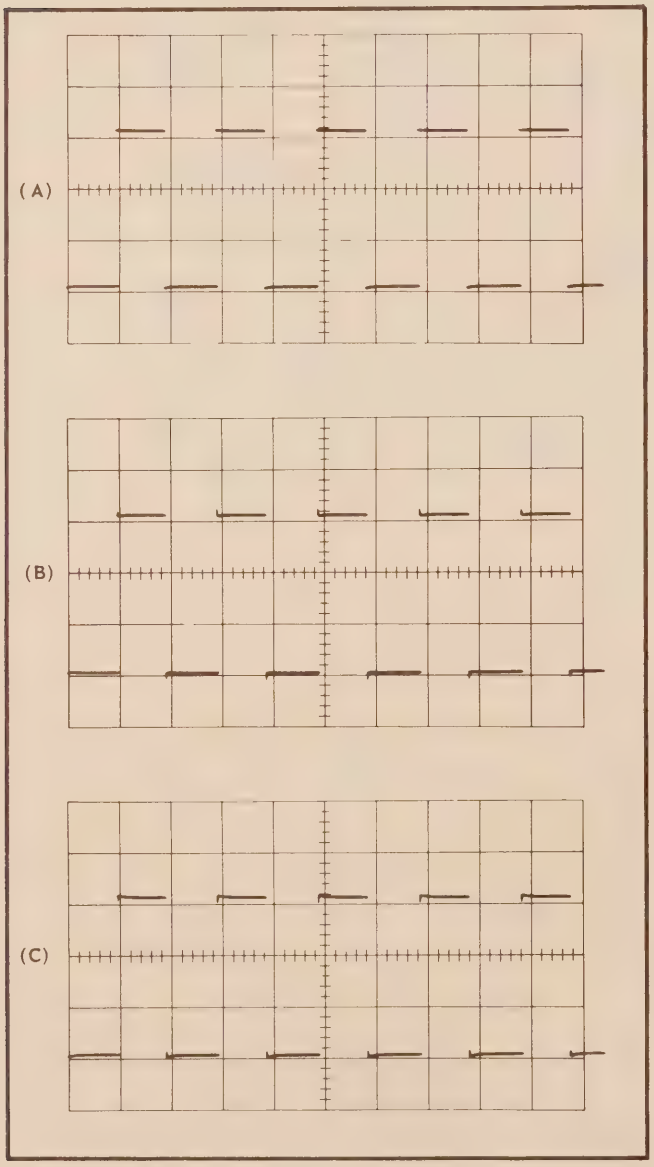


Fig. 5-1. (A) Typical CRT display showing correct VOLTS/CM switch compensation; (B) and (C) incorrect compensation. Sweep rate is 0.5 msec/cm.

b. Apply a 3 cm, 1 kHz square wave signal from the Square-Wave Generator through a GR to BNC adapter, a 50 Ω coaxial cable, a 50 Ω termination and a 20 pF Input RC Standardizer to the CHANNEL A Input connector.

c. Check—Flat top waveform with not more than 1.2 mm rolloff or overshoot. See Fig. 5-1.

d. Change the VOLTS/CM switch to .1 and increase the Square-Wave Generator output amplitude to maintain 3 cm of deflection.

e. Check—Flat top waveform within 1.2 mm rolloff or overshoot.

f. Repeat with VOLTS/CM switch at .2, .5, 1, 2, 5, 10, and 20, increasing the amplitude of the Square-Wave Generator signal to maintain a 3 cm display. Remove the 50 Ω termination from between the 50 Ω coaxial cable and the Standardizer, when necessary to maintain 3 cm amplitude. (Decrease the amplitude when doing this.) If a 3 cm amplitude display is not possible at 20 V/cm, use maximum possible amplitude.

g. Set the Square-Wave Generator output amplitude control to full counterclockwise, remove the Standardizer from the CHANNEL A Input and replace the 50 Ω termination between the coaxial cable and the Standardizer.

h. Repeat the procedure for CHANNEL B.

i. Remove the signal.

j. Set both VOLTS/CM switches to .05.

k. Set the oscilloscope Time/cm switch to 2 μsec.

12. Check High Frequency Compensations, Both Channels

a. Requirement—Square-wave with a maximum rolloff, overshoot, and/or ringing of ± 1 mm with a 4 cm display. Risetime 15 ns or less.

b. Apply an approximate 450 kHz square-wave signal from the Square-Wave Generator through a GR to BNC adapter, a 50 Ω coaxial cable and a 50 Ω termination to the CHANNEL B Input connector.

c. Set the Square-Wave Generator Amplitude for a 4 cm display.

d. Change the Time/cm switch to .2 μsec, Triggering Mode to AC LF Reject and adjust the Trigger Level and Stability for a stable display.

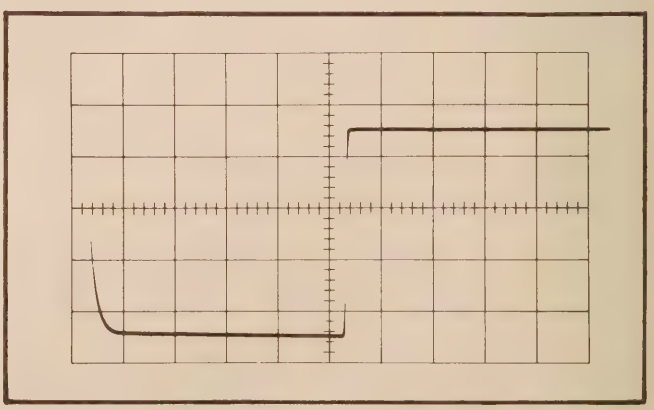


Fig. 5-2. Typical CRT display showing correct high-frequency compensation.

e. Check—Flat top and square corner within ± 1 mm of rolloff, overshoot, and/or ringing. See Fig. 5-2.

f. Change the Time/cm switch to .1 μsec and turn 5× MAG ON (sweep rate is now 20 nsec/cm).

g. Use the Horizontal Position control to move the rise of the square wave to the center of the graticule area.

h. Measure the amount of time the rising portion of the square wave takes to go from 10% to 90% of its amplitude (risetime).

i. Check—Risetime 15 ns or less (¾ cm or less). See Fig. 5-3.

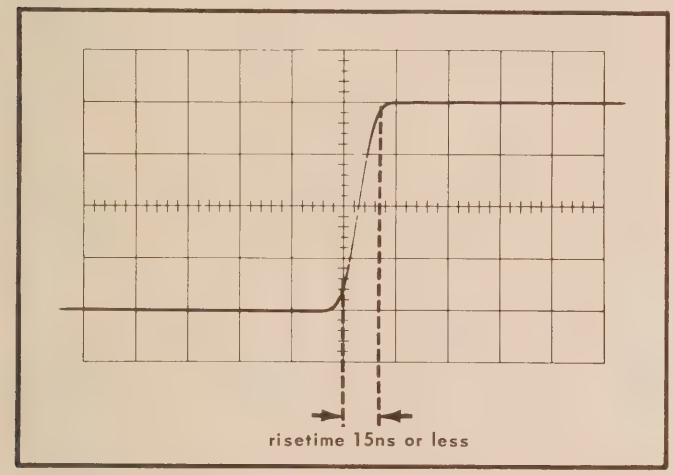


Fig. 5-3. Measuring risetime; sweep rate is 20 nsec/cm.

j. Return the Time/cm switch to 2 μsec and turn the 5× MAG OFF.

k. Change the MODE switch to A ONLY and apply the signal to the CHANNEL A Input connector.

l. Repeat the procedure for CHANNEL A.

m. Remove the signal.

n. Set the Time/cm switch to .1 msec.

13. Check Frequency Response

a. Requirement—Frequency at least 24 MHz at 3 dB down, AC or DC. Low frequency 3 dB down point less than 2 Hz with AC coupling.

b. Set the Stability control to full clockwise.

c. Apply exactly 3 cm of 50 kHz signal to the CHANNEL A Input connector from the Constant Amplitude Signal Generator through a GR to BNC adapter, a 50 Ω coaxial cable and a 50 Ω Termination.

d. Increase the frequency until the amplitude is 2.1 cm.

e. Check—Constant Amplitude Signal Generator frequency at least 24 MHz.

f. Change the AC-DC switch to AC.

g. Check—Amplitude remains 2.1 cm.

h. Change the MODE switch to B ONLY and apply the signal to the CHANNEL B Input connector.

i. Repeat the procedure for CHANNEL B.

j. Remove the signal from the CHANNEL B Input.

k. Set both AC-DC switches to AC, VOLTS/CM switches to 5, and the oscilloscope Time/cm switch to .1 sec. Turn the Intensity control counterclockwise until dot is of normal brilliance to avoid burning the CRT.

l. Attach a patch from the +GATE output to the CHANNEL B Input connector; the display will be an RC fall.

m. Adjust the VARIABLE control for an amplitude of 4 cm. (Change the VOLTS/CM switch to 2 if adjustment is not possible at 5.)

n. Measure the fall time of the RC curve from the 4 to 1.5 cm amplitude points. See Fig. 5-4.

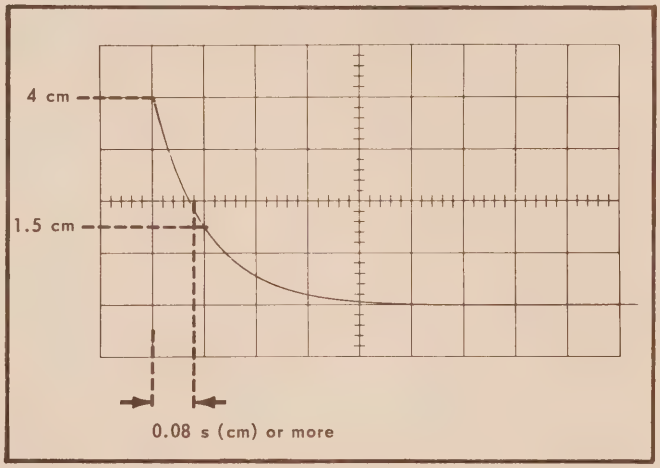


Fig. 5-4. Falling RC Time-Constant curve.

o. Check—Must be 0.08 sec or more (2 Hz or less).

p. Set MODE switch to A ONLY and apply +GATE output to the CHANNEL A Input connector.

q. Measure the RC fall time as before.

r. Remove the +GATE signal.

s. Set both AC-DC switches to DC and change the oscilloscope Time/cm switch to .5 msec.

14. Check High Frequency Common Mode Rejection

a. Requirement—Common mode rejection 20 to 1; 1 cm maximum deflection.

b. Attach a CA Dual Input Assembly to both Input connectors. Connect the Constant Amplitude Signal Generator output through a GR to BNC adapter, a 50 Ω coaxial cable and a 50 Ω termination to the Dual Input Assembly.

c. Set both VOLTS/CM switches to .5.

d. Set the Constant Amplitude Signal General for 2 cm of 50 kHz signal.

e. Change both VOLTS/CM switches to .05.

f. Set MODE switch to ADDED ALGEBRAICALLY.

g. Set the CHANNEL A POLARITY switch to INVERTED.

h. Check—1 cm maximum deflection. If more than 1 cm, change the CHANNEL A POLARITY to NORMAL and the CHANNEL B POLARITY to INVERTED. One method must result in a 1 cm maximum deflection.

i. Increase the Constant Amplitude Signal Generator frequency to 24 MHz.

j. Check—1 cm maximum deflection. The settings of the POLARITY switches may be reversed if the first way shows too much deflection.

k. Remove the signal.

15. Check Alternate Slave (With Type 547 Oscilloscope Only)—Type CA Serial Numbers 64010-up

a. Requirement—Two traces; CHANNEL A trace should sweep at the Time Base A sweep rate and CHANNEL B trace should sweep at the Time Base B sweep rate.

b. Preset the following controls:

Type CA

CHANNELS A & B	
AC-DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED
POLARITY	NORMAL
VERTICAL POSITION	Centered
MODE	ALTERNATE

Type 547

Time Base A & B	
Triggering Level	Clockwise
Mode	Auto
Slope	+
Coupling	AC
Source	Norm
Time/cm	.5 msec
Horizontal Display	B
Intensity, Focus, and Astigmatism	Adjusted for a well focused normally brilliant trace.
Scale Illum	User's preference
Trace Separation	0 (zero)

c. Set the traces 2 cm apart with the VERTICAL POSITION controls.

d. Set the Type 547 Horizontal Display to A ALT B.

e. Rotate the Trace Separation control.

f. Check—Two traces only.

g. Set the Time Base B Time/cm switch to 50 msec.

h. Check—CHANNEL A trace sweeps at Time Base A sweep rate of .5 msec and CHANNEL B trace sweeps at Time Base B sweep rate of 50 msec.

This completes the performance check procedure for the Type CA. Disconnect all test equipment. If the instrument has met all performance requirements given in this procedure, it is correctly calibrated and within the specified tolerances.

SECTION 6

CALIBRATION

Introduction

Information contained in this section is provided as an aid to recalibrating and checking the operation of the Type CA Plug-In Unit. In addition, this section may be used to isolate troubles occurring within the unit.

Apparent troubles in the unit are often the result of improper calibration of one or more circuits. Consequently, calibration checks should be an integral part of the troubleshooting procedure. Abnormal indications occurring during calibration checks will often aid in isolating troubles to a definite circuit or stage.

In the instructions that follow, the steps are arranged in the proper sequence for a complete recalibration of the instrument. Each numbered step contains the information required to make one check, one adjustment, or a series of related adjustments or checks. The steps are arranged so that unnecessary repetition of certain checks is avoided.

In each calibration step only the required information is given. Detailed instructions pertaining to normal operation of the instrument are not included. If you are in doubt as to the proper operation of controls, refer to the Operating Instructions.

Controls not mentioned in a particular calibration step are assumed to be in the positions they were in during the previous step. All test equipment used in any particular step should be disconnected at the end of the step unless you are instructed to the contrary.

If a single control requires adjustment, it can be adjusted in the applicable step of this procedure without performing other steps as well. It will be necessary, however, that you refer to the calibration steps immediately preceding the adjustment you wish to make to determine the proper settings for the controls not mentioned in that step.

If you suspect that the unit is out of calibration but you are not aware of which particular adjustment will correct the difficulty, it is usually best to run through the entire calibration procedure. In this way you can be certain that the unit is properly calibrated without resorting to a method of random experimentation.

EQUIPMENT REQUIRED

The following equipment or its equivalent is required to perform a complete calibration of the Type CA Plug-In Unit. It is assumed that all equipment listed is within its manufacturer's specifications. If there is any doubt, the test equipment should be calibrated before it is used. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

1. DC voltmeter. Minimum sensitivity, 20,000 ohms/volt. Triplett Model 630 or Simpson Model 262 recommended.

2. Tektronix 540-Series convertible oscilloscope or equivalent. Type 547 recommended (necessary to check Alternate Slave feature).

3. Standard amplitude calibrator. Amplitude accuracy, 0.25%; signal amplitude, 5 millivolts to 100 volts peak to peak; output signal, 1 kHz. Tektronix calibration fixture 067-0502-00 recommended.

NOTE

An amplitude calibrator of 1% or better must be used to check and/or set the deflection factor of the Type CA to an accuracy of ±3%. If the calibrator of the oscilloscope (item 2) is used, accuracy of the plug-in unit will be ±6%. If an accuracy of ±6% is sufficient, use the calibrator of the oscilloscope instead of item 3.

4. Square-wave generator. Frequency, 1 kHz; risetime, 13 ns or less into a 50-ohm cable terminated at both ends; output amplitude variable from 10 to 100 volts across a 600-ohm load. Tektronix Type 106 or Type 105 Square-Wave Generator recommended.

5. Square-wave generator. Frequency, about 450 kHz; risetime, less than 3 ns into a terminated 50-ohm cable; output voltage, 0.1 to 0.5 volts terminated in 50 ohms. Tektronix Type 106 or Type 107 Square-Wave Generator recommended.

6. Constant amplitude signal generator. Frequency, 50 kHz and 350 kHz to 30 MHz; amplitude accuracy, ±2%. Tektronix Type 191 or Type 190B recommended.

7. 20 pF Input RC Standardizer. Tektronix Part No. 011-0066-00 BNC connectors; 011-0022-00 UHF connectors.

8. 50 Ω Termination resistor, Tektronix Part No. 011-0049-00 BNC; 011-0045-00 UHF.

9. 50 Ω coaxial cable, 42 inches long, Tektronix Part No. 012-0057-00 BNC; 012-0001-00 UHF.

10. CA Dual Input Connector, Tektronix calibration fixture 067-0525-00 with BNC connectors; Tektronix Part No. 003-0035-00 with UHF connectors.

11. Adapter. Connectors, GR to BNC jack. Tektronix Part No. 017-0063-00.

12. Patch cord (two) with banana plug and BNC connector. Length, 18 inches. Tektronix Part No. 013-0090-00.

13. Adjustment tools.

a. Insulated screwdriver, Tektronix Part No. 003-0000-00.

b. Low-capacitance alignment tool consisting of a handle, Tektronix Part No. 003-0307-00, and a $5/64$ inch hexagonal wrench insert, Part No. 003-0310-00, and an insert with a wire pin, Part No. 003-0334-00.

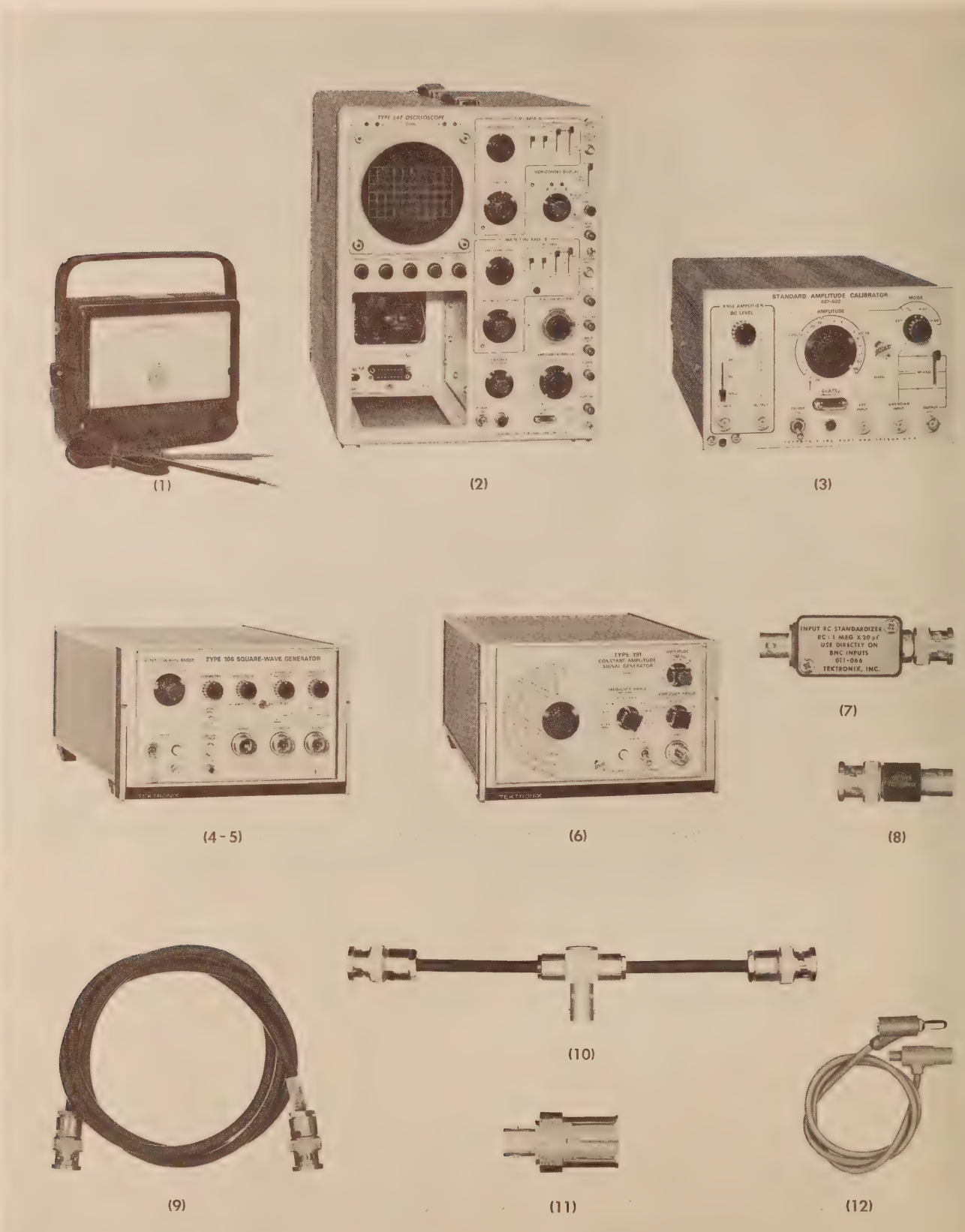


Fig. 6-1. Equipment required for calibration of the Type CA.

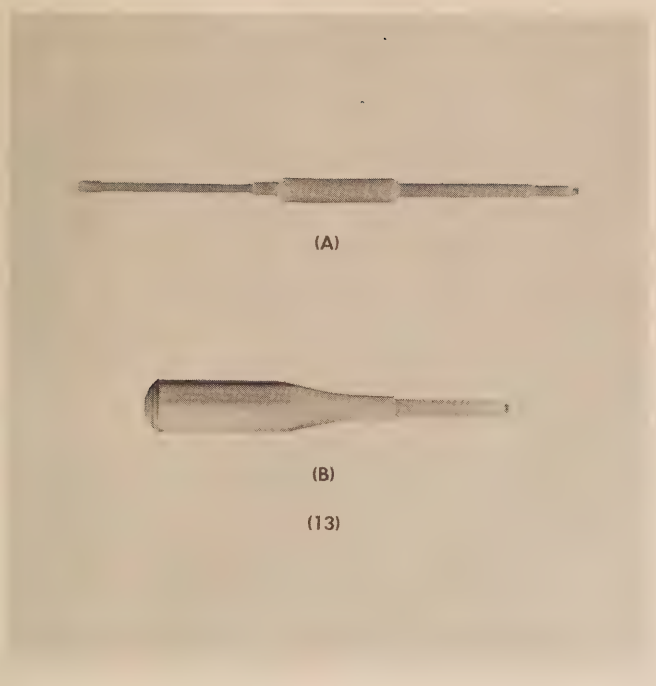


Fig. 6-2. Calibration tools.

ABRIDGED CALIBRATION PROCEDURE AND INDEX

This Abridged Calibration Procedure is provided to aid in checking the operation of the Type CA Plug-In Unit. It may be used as a calibration guide by the experienced calibrator, or it may be used as a calibration record. Since the step numbers and titles used here correspond to those used in the complete Calibration procedure, the following procedure serves as an index to locate a step in the complete Calibration Procedure. Characteristics are those listed in the Characteristics section of the Instruction Manual.

Type CA, Serial No. _____

Calibration Date _____

☐ 1. Check Output DC Level. Page 6-5.
+65 to +70 volts.

☐ 2. Adjust DC Balance. Page 6-5.
No trace shift as VARIABLE control is rotated.

☐ 3. Check Grid Current and Microphonics. Page 6-5.
Grid Current trace shift maximum of ±3 mm.
Microphonics maximum 2 mm, no ringing type.

☐ 4. Adjust Vertical Position Range. Page 6-5.
Both traces equidistant from CRT electrical center.

☐ 5. Check Polarity Trace Shift. Page 6-5.
Maximum ±1.5 cm, slow drift maximum ±2 mm as POLARITY is changed from NORMAL to INVERTED.

☐ 6. Check Added Algebraically Trace Shift. Page 6-5.
Maximum ±2 cm of CRT electrical center.

☐ 7. Check Alternate Mode and Slave Pulse Operation. Page 6-6.
Alternate sweeps at all sweep rates between 5 s and .1 μs.

☐ 8. Check Chopped Mode Operation. Page 6-6.
Frequency: 100 kHz ±30%
Symmetry: ratio 3:2, maximum
Flat top: distortion 1 mm, maximum

☐ 9. Adjust Gain. Page 6-7.
GAIN ADJ range, ±5%.

☐ 10. Check AC-DC Switch Operation. Page 6-7.
Waveform shift downward 1 cm, approx.

☐ 11. Check Added Algebraically Mode Operation. Page 6-8.
Added error ±3%
Common mode rejection ratio 20:1. (1 cm max deflection).

☐ 12. Check VOLTS/CM Switch Accuracy and VARIABLE Range. Page 6-8.
VOLTS/CM switch accauracy, ±3%
VARIABLE range, 2.5 to 1 minimum.

☐ 13. Adjust CHANNEL A Input Capacity. Page 6-9.
Best square-wave.

☐ 14. Adjust CHANNEL A VOLTS/CM compensation. Page 6-9.
Best square-wave all positions of switch.

☐ 15. Adjust CHANNEL B Input Capacity. Page 6-10.
Best square-wave.

☐ 16. Adjust CHANNEL B VOLTS/CM Compensation. Page 6-10.
Best square-wave all positions of switch.

☐ 17. Adjust High Frequency Compensations. Page 6-13.
Best square-wave at high frequency.

☐ 18. Check Frequency Response. Page 6-14.
At least 24 MHz at 3 dB down.

☐ 19. Adjust DC Balance. Page 6-14.
No trace shift as VARIABLE control is rotated.

☐ 20. Check High Frequency Common Mode Rejection. Page 6-15.
Common mode rejection ratio 20:1 (1 cm max. deflection).

CALIBRATION PROCEDURE

General

In the following calibration procedure, a test equipment setup is shown for each major setup change. Complete control settings are listed beneath the picture. If only a partial calibration is performed, start with the nearest setup preceding the desired portion.

NOTE

When performing a complete recalibration, best performance will be provided if each adjustment is made to the exact setting, even if the Check is within the allowable tolerance.

The following procedure uses the equipment listed under Equipment Required. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

a. Install the CA Unit in the oscilloscope vertical plug-in compartment.

b. Remove the left side cover from the oscilloscope.

c. Turn on the oscilloscope and all test equipment and allow 15 minutes for warm-up and stabilization.

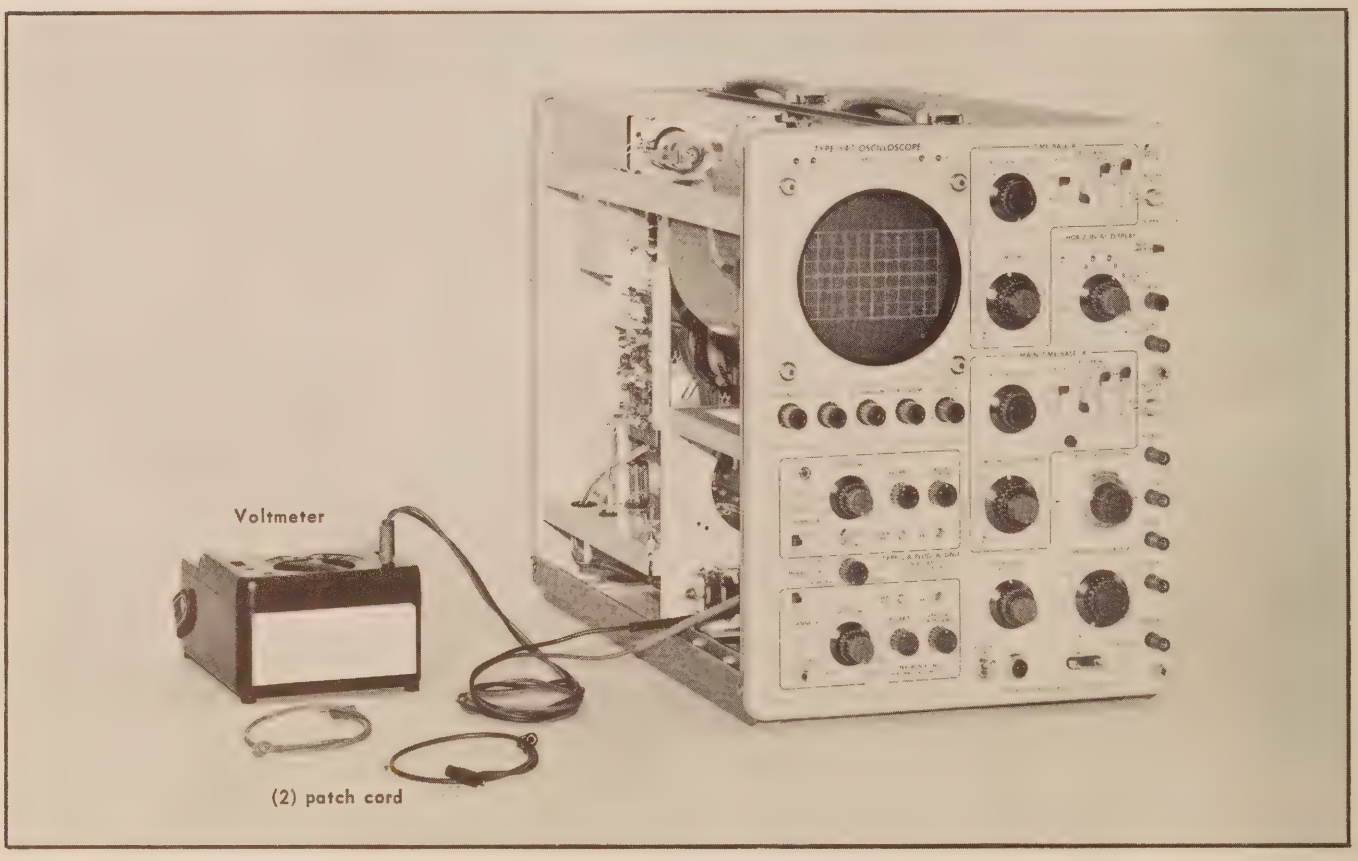


Fig. 6-3. Equipment setup for steps 1 through 8.

Control Settings

Test Oscilloscope

Horizontal Display	B (546, 547) Normal or A
Sweep Magnifier	×1 off (546, 547)
Single Sweep Switch	Normal
Triggering Level	0
Triggering Source	Norm Int
Triggering Coupling	AC
Triggering Slope	— (minus)
Triggering Mode	Auto
Stability	Full clockwise
Time/cm	1 msec
Variable (Time/cm)	Calibrated
Horizontal Position	Centered
Vernier (Horizontal Position)	Centered
CRT Cathode Selector	CRT Cathode
Amplitude Calibrator	Off

Type CA

Channels A and B	
AC-DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED
POLARITY	NORMAL
VERTICAL POSITION	Centered
MODE	ALTERNATE

NOTE

Some of the Tektronix oscilloscopes with which a Type CA may be used have both a Time-Base A and a Time-Base B. Control settings listed apply to the Main Time Base on these oscilloscopes. That is, Time Base A on all except Types 546 and 547, where Time Base B is the Main Time Base.

1. Check Output DC Level

a. Equipment setup is shown in Fig. 6-3.

b. Connect the voltmeter between Amphenol connector pin 1 and ground.

c. Check—Meter reading; 65 to 70 volts.

d. Connect the voltmeter between Amphenol connector pin 3 and ground.

e. Check—Meter reading; 65 to 70 volts.

f. Disconnect the voltmeter.

2. Adjust DC Balance

a. Equipment setup is given in step 1.

b. CRT electrical center—Momentarily short Amphenol connector pins 1 and 3 together and note vertical position of the trace.

c. Position the A trace to the electrical center with VERTICAL POSITION control.

d. Rotate the CHANNEL A VARIABLE control while adjusting the CHANNEL A DC BAL control for no trace shift.

e. Position the B trace to the electrical center with the CHANNEL B VERTICAL POSITION control.

f. Rotate the CHANNEL B VARIABLE control while adjusting the CHANNEL B DC BAL control for no trace shift.

g. Return both VARIABLE controls to the detent position.

3. Check Grid Current and Microphonics

a. Equipment setup is as given in step 2.

b. Ground both CHANNEL A and B Input connectors and separate the traces.

c. Change the AC-DC switches to AC.

d. Check—Trace shift less than ±3 mm.

e. Rotate the CHANNEL A VOLTS/CM switch through its range.

f. Check—Microphonics less than 2 mm with no ringing type.

g. Rotate the CHANNEL B VOLTS/CM switch through its range.

h. Check—Microphonics less than 2 mm with no ringing type.

i. Set both VOLTS/CM switches to .05.

j. Set both AC-DC switches to DC.

4. Adjust Vertical Position Range

a. Equipment setup is as given in step 3.

b. Set both VERTICAL POSITION controls to the center of rotation (dots straight up).

c. Check the DC BAL adjustments in both channels (see step 2).

d. Check—Trace separation no more than 3 cm.

e. Adjust—Vert Pos Range, R4376, so both traces are equidistant above and below the CRT electrical center (see Fig. 6-4 for location).

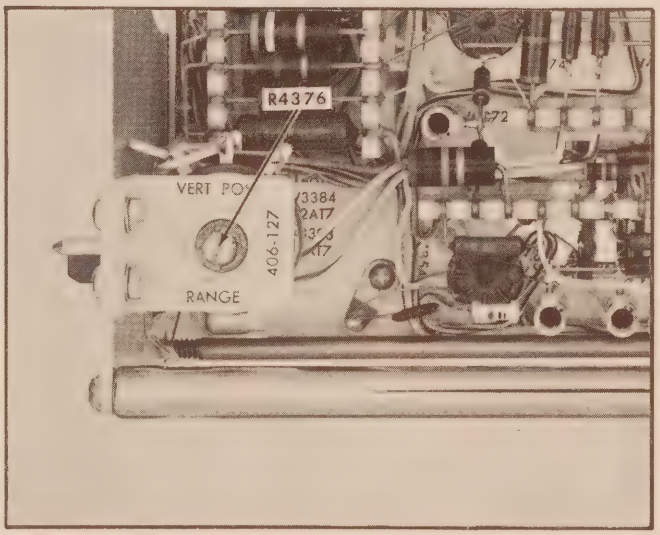


Fig. 6-4. Location of Vert Pos Range, R4376, adjustment.

5. Check Polarity Trace Shift

a. Equipment setup is as given in step 4.

b. Center the A trace with the CHANNEL A VERTICAL POSITION control.

c. Change the POLARITY from NORMAL to INVERTED.

d. Check—Trace shift less than ±1.5 cm with a slow drift less than ±2 mm (ignore rapid or spurious movements.)

e. Repeat the procedure for CHANNEL B.

f. Return both POLARITY switches to NORMAL.

6. Check Added Algebraically Trace Shift

a. Equipment setup as given in step 5.

b. Position both traces to the CRT electrical center with the VERTICAL POSITION controls.

c. Change the MODE switch to ADDED ALGEBRAICALLY.

d. Check—Trace shift no more than ±2 cm.

e. Return the MODE switch to ALTERNATE.

7. Check Alternate Mode and Slave Pulse Operation

a. Equipment setup as given in step 6.

b. Position traces 2 cm apart with VERTICAL POSITION controls.

c. Change the oscilloscope Time/cm switch to .1 μsec.

d. Check—Display alternates between A and B traces with Time/cm switch at all settings. Wait for one complete alternation before proceeding. At slower sweep rates, turn the INTENSITY control counterclockwise to avoid possible damage to the CRT phosphor.

e. Set the Time/cm switch to .5 msec.

f. Set the Horizontal Display to ALT.

g. Set the Time Base A Time/cm switch to 50 msec.

h. Rotate the TRACE SEPARATION control.

i. Check—Only two traces present.

j. Check—CHANNEL A trace should sweep at 50 msec (Time Base A sweep rate) and CHANNEL B trace should sweep at .5 msec (Time Base B sweep rate).

k. Return the Horizontal Display to B or Normal.

NOTE

Steps e through k apply to the Type 547 Oscilloscope and CA Units with serial numbers 64010 and up.

8. Check Chopped Mode Operation

a. Equipment setup is given in step 7.

b. Set MODE switch to CHOPPED.

c. Change the oscilloscope Time/cm switch to 10 μsec, Triggering Mode to Auto and turn the Intensity clockwise for normal trace brightness.

d. Check—Duration of one complete cycle between .7 and 1.3 cm, which is 100 kHz ±30%.

e. Compare lengths of the top and bottom lines of the display.

f. Check—Symmetry ratio 3:2 or 2:3 maximum.

g. Set oscilloscope CRT Cathode Selector switch, at the rear of the oscilloscope, to Dual Trace Chopped Blanking.

h. Check—Rising and falling portions of the chopped waveform are blanked (not visible). It may be necessary to reduce intensity to observe the blanking.

i. Change the oscilloscope Time/cm to 1 μsec.

j. Check—Distortion of the flat top of the waveform no more than 1 mm.

k. Return the oscilloscope CRT Cathode Selector to External CRT Cathode and the Time/cm switch to 1 msec.

l. Remove the ground connections at the Input connectors.

NOTES

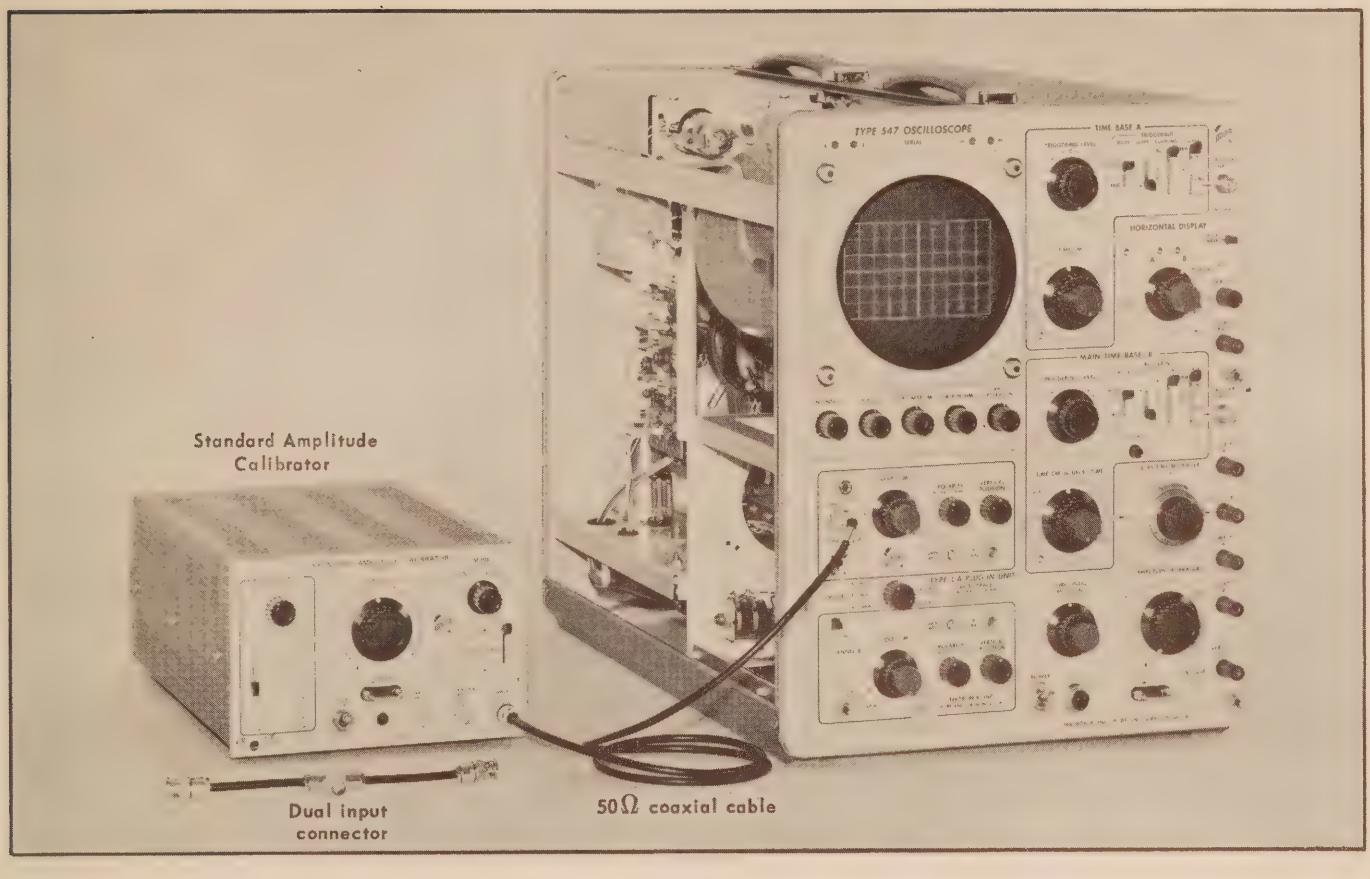


Fig. 6-5. Equipment setup for steps 9 through 12.

Control Settings

Test Oscilloscope

Horizontal Display	B (546, 547) Normal or A
Sweep Magnifier	×1 off (546, 547)
Single Sweep Switch	Normal
Triggering Level	0
Triggering Source	Norm Int
Triggering Coupling	AC
Triggering Slope	— (minus)
Triggering Mode	Auto
Stability	Full clockwise
Time/cm	1 msec
Variable (Time/cm)	Calibrated
Horizontal Position	Centered
Vernier (Horizontal Position)	Centered
CRT Cathode Selector	CRT Cathode
Amplitude Calibrator	Off

Type CA

Channels A and B	
AC-DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED
POLARITY	NORMAL
VERTICAL POSITION	Centered
MODE	A ONLY

9. Adjust Gain

a. Equipment setup as shown in Fig. 6-5.

b. Set the MODE switch to A ONLY.

c. Apply .1 V from the Standard Amplitude Calibrator to the CHANNEL A Input connector.

d. Rotate the GAIN ADJ control clockwise.

e. Check—Amplitude at least 2.1 cm.

f. Rotate the GAIN ADJ control counterclockwise.

g. Check—Amplitude not more than 1.9 cm.

h. Adjust GAIN ADJ control for exactly 2 cm deflection.

i. Repeat the procedure for CHANNEL B.

10. Check AC-DC Switch Operation

a. Equipment setup is given in step 9.

b. Position the bottom of the calibrator waveform at the center graticule line.

c. Change the CHANNEL B AC-DC switch to AC.

d. Check—Waveform shift downward 1 cm ±2 mm.

e. Repeat the procedure for CHANNEL A.

f. Remove the signal and set both AC-DC switches to DC.

11. Check Added Algebraically Mode Operation

a. Equipment setup is as given in step 10.

b. Apply .1 V from the Standard Amplitude Calibrator to both CHANNEL A and B Inputs through the Dual Input Connector.

c. Set the MODE switch to ADDED ALGEBRAICALLY.

d. Check—Observe 4 cm deflection, ±3%.

e. Change CHANNEL A or B POLARITY to INVERTED.

f. Increase the Standard Amplitude Calibrator to 1 V.

g. Check—Trace amplitude no more than 1 cm, rejection ratio is 20:1.

NOTE

If trace amplitude is over 1 cm, vary the VERTICAL POSITION controls. If it is still over 1 cm, reverse the POLARITY switches and again vary the VERTICAL POSITION controls. One method must result in 1 cm or less deflection.

12. Check VOLTS/CM Switch Accuracy and VARIABLE Range

a. Equipment setup is as given in step 11.

b. Set the MODE switch to A ONLY and the POLARITY switches to NORMAL.

c. Remove the Dual Input Connector and apply the signal from the Standard Amplitude Calibrator to the CHANNEL A Input.

TABLE 6-1

VOLTS/CM switch setting	Standard Amplitude Calibrator, Volts	Deflection ±3% max
.05	.1	2 cm, adjusted
.1	.2	2 cm, ±.6 mm
.2	.5	2.5 cm, ±.75 mm
.5	1	2 cm, ±.6 mm
1	2	2 cm, ±.6 mm
2	5	2.5 cm, ±.75 mm
5	10	2 cm, ±.6 mm
10	20	2 cm, ±.6 mm
20	50	2.5 cm, ±.75 mm

d. Check using Table 6-1 as a guide.

e. Set the VARIABLE control to maximum attenuation, with the VOLTS/CM switch at 20 and 50 V applied.

f. Check—Amplitude 1 cm maximum, attenuation ratio 2.5:1.

NOTE

If turning the VARIABLE control causes erratic jumping of the trace, the control is defective.

g. Return the VARIABLE control to CALIBRATED (detent).

h. Repeat the procedure for CHANNEL B.

i. Remove the Standard Amplitude Calibrator signal.

NOTES

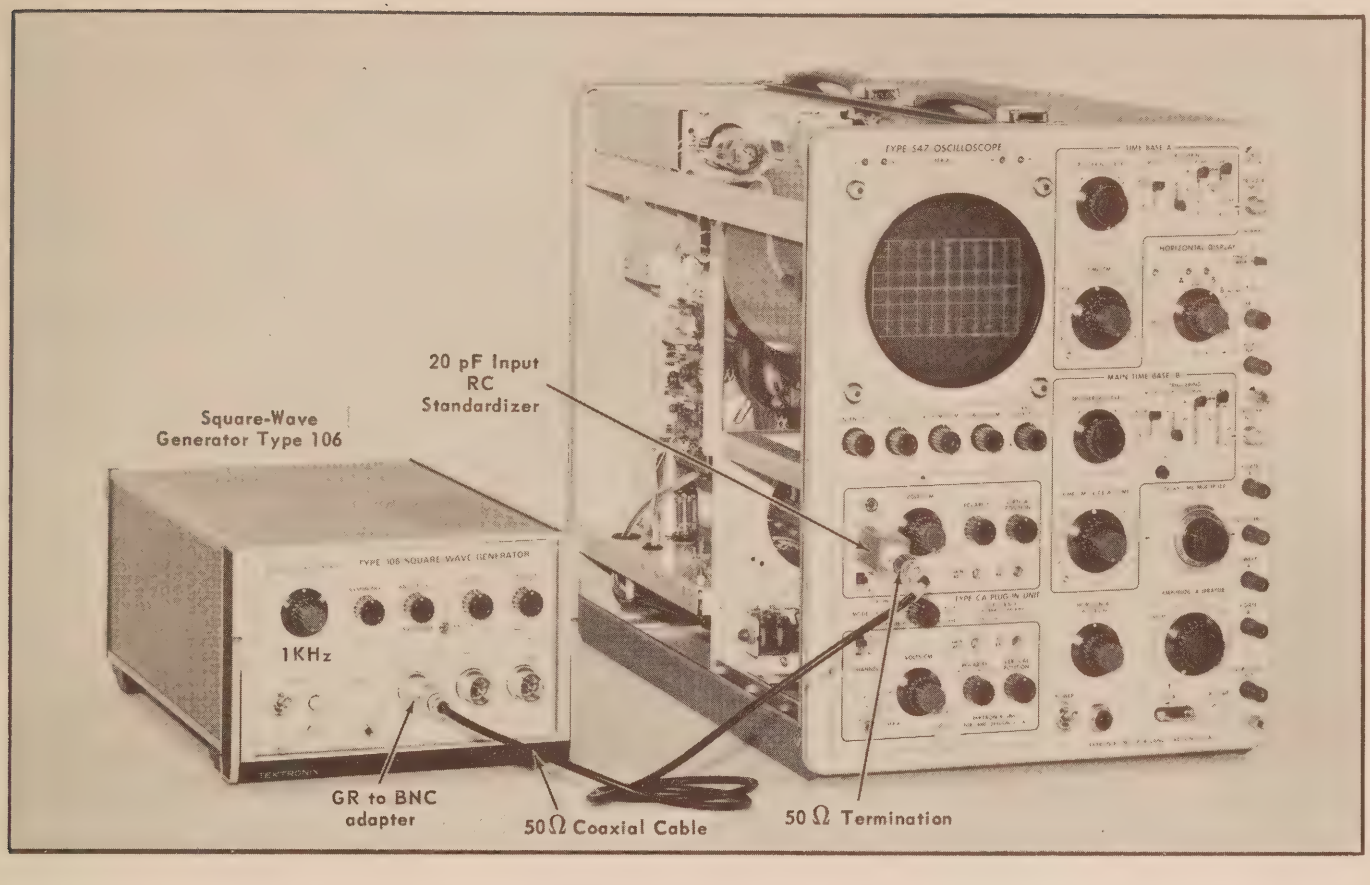


Fig. 6-6. Equipment setup for steps 13 through 16.

Control Settings

Test Oscilloscope

Horizontal Display	B (546, 547) Normal or A
Sweep Magnifier	×1 off (546, 547)
Single Sweep Switch	Normal
Triggering Level	0
Triggering Source	Norm Int
Triggering Coupling	AC
Triggering Slope	— (minus)
Triggering Mode	Auto
Stability	Full clockwise
Time/cm	1 msec
Variable (Time/cm)	Calibrated
Horizontal Position	Centered
Vernier (Horizontal Position)	Centered
CRT Cathode Selector	CRT Cathode
Amplitude Calibrator	Off

Type CA

Channels A and B

AC-DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED
POLARITY	NORMAL
VERTICAL POSITION	Centered
MODE	A ONLY

13. Adjust CHANNEL A input Capacity

a. Equipment setup is given in Fig. 6-6.

b. Set the MODE switch to A ONLY and the VOLTS/CM switch to .05.

c. Apply a 3.5 cm, 1 kHz square wave signal from a Square-Wave Generator through a GR to BNC adapter, a 50 Ω coaxial cable, a 50 Ω termination and a 20 pF Input RC Standardizer to the CHANNEL A Input connector.

d. Adjust C3322, input shunt capacitor, for best square wave.

14. Adjust CHANNEL A VOLTS/CM Compensation

a. Equipment setup is as given in step 13.

b. Maintain a 3.5 cm 1 kHz signal from the Square-Wave Generator and adjust for best square wave (see Fig. 6-7) according to Table 6-2. See Fig. 6-8 for location.

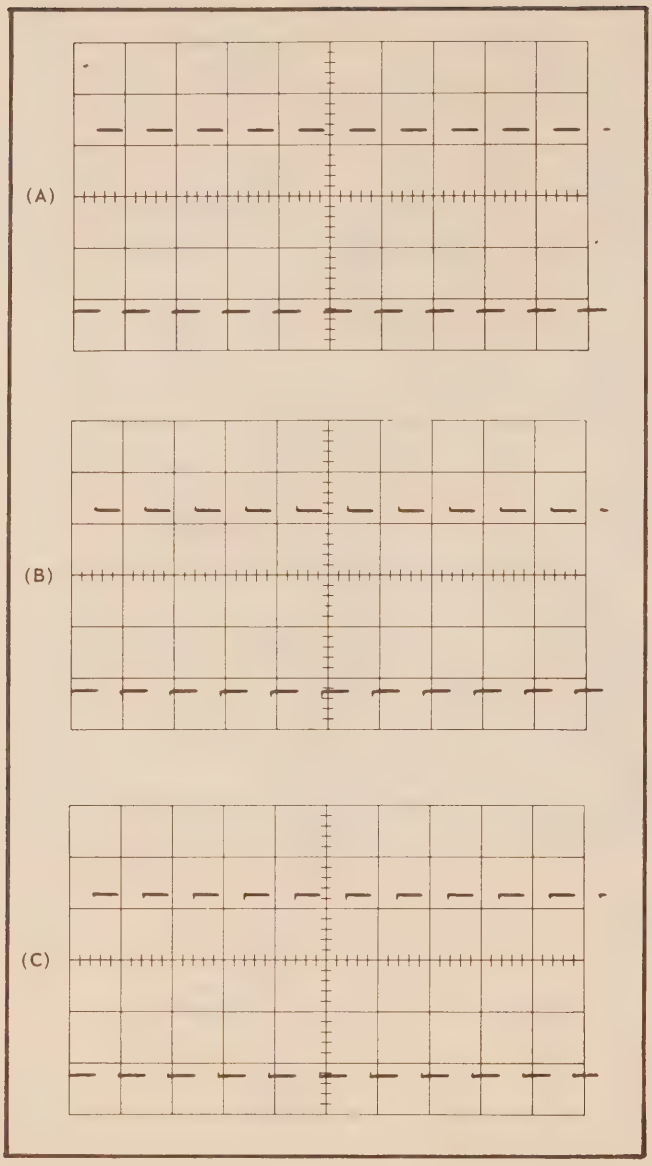


Fig. 6-7. (A) Typical CRT display showing correct VOLTS/CM switch compensation; (B) and (C) incorrect compensation.

TABLE 6-2

VOLTS/CM switch	Adjust for Optimum Square Corner	Adjust for Optimum Flat Top
.1	C3311C	C3311B
.2	C3312C	C3312B
.5	C3313C	C3313B
1	C3314C	C3314B
2	C3315C	C3315B
5	C3316C	C3316B
10	C3317C	C3317B
20	C3318C	C3318B

Remove the 50 Ω termination from between the 50 Ω coaxial cable and the Standardizer, when necessary to maintain 3.5 cm amplitude. (Decrease the output amplitude when doing this.) If a 3.5 cm amplitude display is not possible at 20 V/cm, use maximum possible amplitude.

15. Adjust CHANNEL B Input Capacity

a. Equipment setup as given in step 14.

b. Set MODE switch to B ONLY and CHANNEL B VOLTS/CM switch to .05.

c. Replace the 50 Ω termination between the 50 Ω coaxial cable and the Standardizer, and apply the signal from the Square-Wave Generator to the CHANNEL B input, keeping 3.5 cm of the 1 kHz signal. (Decrease the output amplitude when replacing the 50 Ω termination.)

d. Adjust C4322, input shunt capacitor, for best square wave.

16. Adjust CHANNEL B VOLTS/CM Compensation

a. Equipment setup is given in step 15.

b. Main a 3.5 cm 1 kHz signal from the Square-Wave Generator and adjust for best square wave (see Fig. 6-7) according to Table 6-3. See Fig. 6-8 for location.

Remove the 50 Ω termination from between the 50 Ω coaxial cable and the Standardizer, when necessary to maintain 3.5 cm amplitude. (Decrease the output amplitude when doing this.) If a 3.5 cm amplitude display is not possible at 20 V/cm, use the maximum possible amplitude.

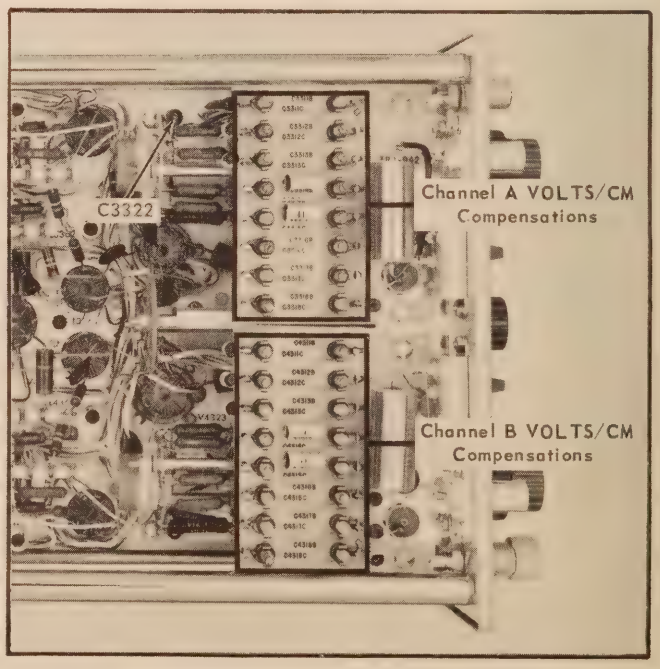


Fig. 6-8. Location of VOLTS/CM switch compensations.

TABLE 6-3

VOLTS/CM Switch	Adjust for Optimum Square Corner	Adjust for Optimum Flat Top
.1	C4311C	C4311B
.2	C4312C	C4312B
.5	C4313C	C4313B
1	C4314C	C4314B
2	C4315C	C4315B
5	C4316C	C4316B
10	C4317C	C4317B
20	C4318C	C4318B

NOTES

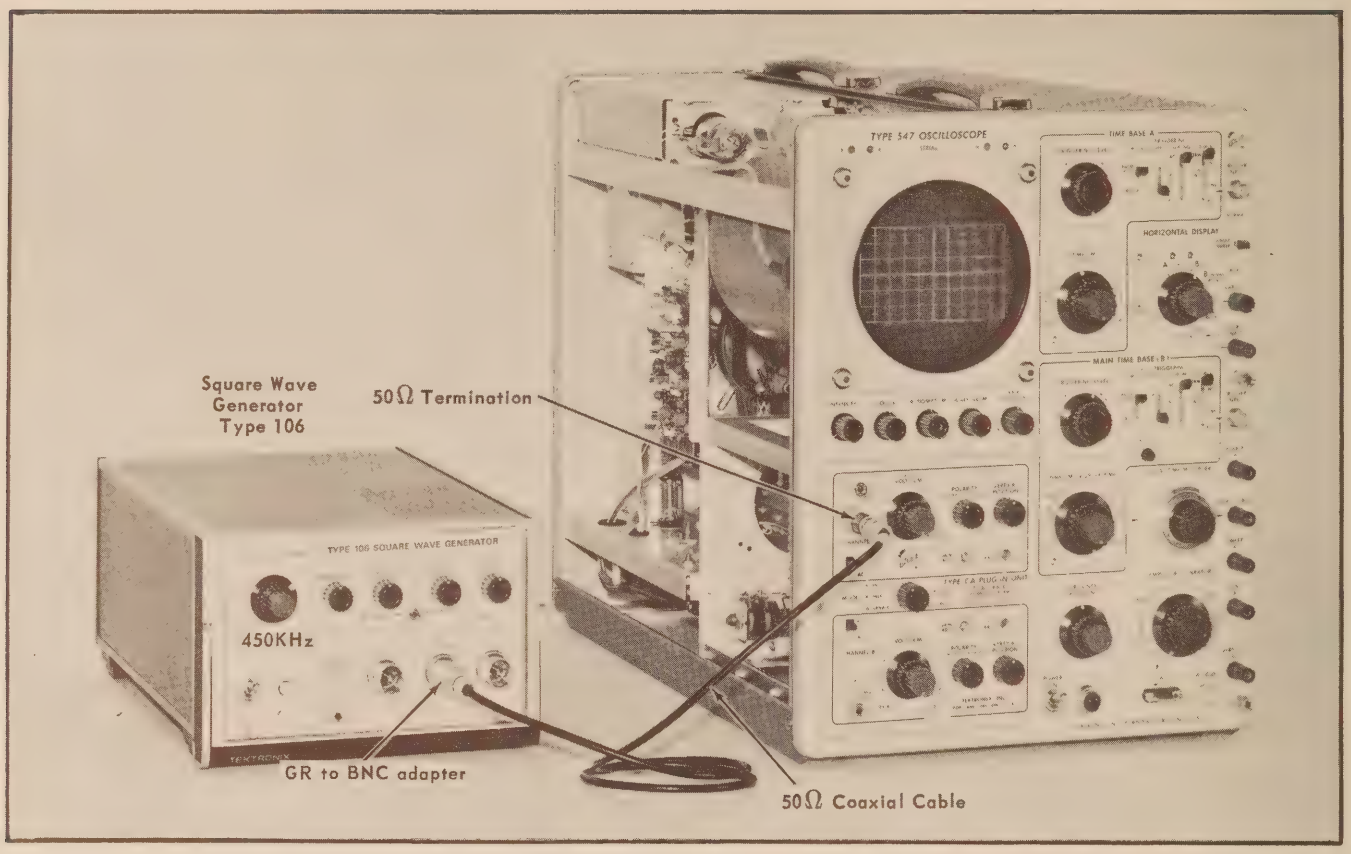


Fig. 6-9. Equipment setup for step 17.

Control Settings

Test Oscilloscope

Horizontal Display	B (546, 547) Normal or A
Sweep Magnifier	×1 off (546, 547)
Single Sweep Switch	Normal
Triggering Level	0
Triggering Source	Norm Int
Triggering Coupling	AC LF Reject
Triggering Slope	— (minus)
Triggering Mode	Auto
Stability	Full clockwise
Time/cm	.2 msec
Variable (Time/cm)	Calibrated
Horizontal Position	Centered
Vernier (Horizontal Position)	Centered
CRT Cathode Selector	CRT Cathode
Amplitude Calibrator	Off

Type CA

Channels A and B

AC-DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED
POLARITY	NORMAL
VERTICAL POSITION	Centered
Mode	A ONLY

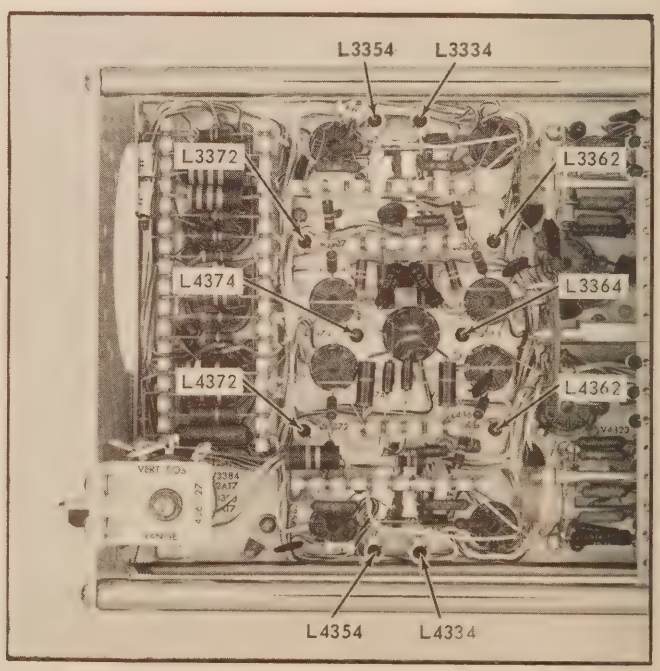


Fig. 6-10. Location of high-frequency adjustments.

17. Adjust High Frequency Compensations ◑

a. Equipment setup is as shown in Fig. 6-9.

b. Set the MODE switch to A ONLY and the CHANNEL A VOLTS/CM to .1.

c. Apply an approximate 450 kHz square-wave from the Square-Wave Generator Fast Rise output through a GR to BNC adapter, a 50 Ω coaxial cable and a 50 Ω termination to the CHANNEL A Input connector.

d. Set the Amplitude for a 3 cm display.

e. Change the Time/cm switch to .2 μsec, Triggering Mode to AC LF Reject and adjust the Trigger Level and Stability for a stable display.

f. Adjust the following inductors for the best square-wave: L3364, L4374, L3362, L3372, L3334, and L3354. See Fig. 6-10 for location.

g. Change the CHANNEL A VOLTS/CM switch to .05 and square-wave amplitude for 4 cm.

h. Check—Square-wave overshoot or roll-off within ±1 mm, see Fig. 6-11.

i. Set the MODE switch to B ONLY and the CHANNEL B VOLTS/CM to .1.

j. Apply the Square-Wave Generator Fast Rise output to the CHANNEL B Input connector.

k. Set amplitude of display to 3 cm.

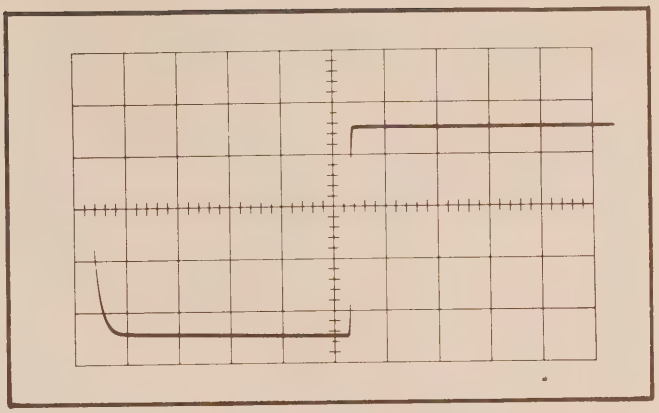


Fig. 6-11. Typical CRT display showing correct high-frequency compensation.

l. Adjust the following inductors for the best square-wave: L4362, L4372, L4434 and L4354. See Fig. 6-10 for location.

m. Change the CHANNEL B VOLTS/CM to .05 and the square-wave amplitude to 4 cm.

n. Check—Square-wave overshoot or roll-off within ±1 mm.

o. Remove the signal.

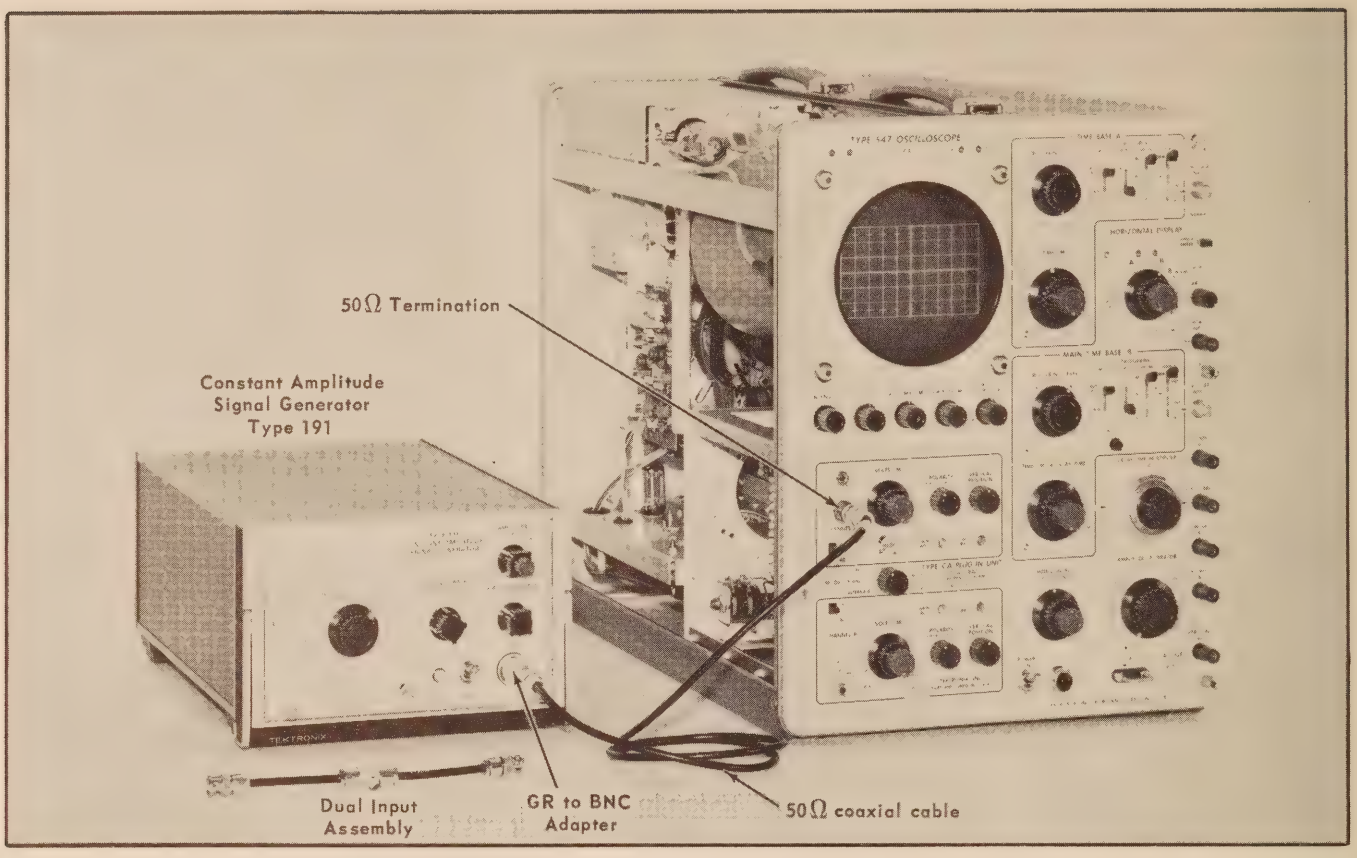


Fig. 6-12. Equipment setup for steps 18 and 20.

Control Settings

Test Oscilloscope

Horizontal Display	B (546, 547) Normal or A
Sweep Magnifier	×1 off (546, 547)
Single Sweep Switch	Normal
Triggering Level	0
Triggering Source	Norm Int
Triggering Coupling	AC
Triggering Slope	— (minus)
Triggering Mode	Auto
Stability	Full clockwise
Time/cm	.1 msec
Variable (Time/cm)	Calibrated
Horizontal Position	Centered
Vernier (Horizontal Position)	Centered
CRT Cathode Selector	CRT Cathode
Amplitude Calibrator	Off

Type CA

Channels A and B	
AC-DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED
POLARITY	NORMAL
VERTICAL POSITION	Centered
MODE	A ONLY

18. Check Frequency Response

a. Equipment setup is shown in Fig. 6-12.

b. Change the oscilloscope Time/cm switch to .1 msec.

c. Set the MODE switch to A ONLY.

d. Apply exactly 3 cm of 50 kHz signal to the CHANNEL A Input connector from the Constant Amplitude Signal Generator through a GR to BNC adapter, a 50 Ω coaxial cable and a 50 Ω termination.

e. Increase the frequency until the deflection is 2.1 cm.

f. Check—Frequency is at least 24 MHz.

g. Repeat the procedure for CHANNEL B.

h. Remove the Constant Amplitude Signal Generator.

19. Adjust DC Balance

a. Move the trace to the CRT electrical center with the CHANNEL B VERTICAL POSITION control.

b. Adjust the CHANNEL B DC BAL control for no trace shift while rotating the VARIABLE control.

c. Set the MODE switch to A ONLY.

d. Repeat the adjustment for CHANNEL A.

20. Check High Frequency Common Mode Rejection

a. Equipment setup is as shown in Fig. 6-12.

b. Set both VOLTS/CM switches to .5.

c. Apply the Constant Amplitude Signal Generator output to both input connectors through a GR to BNC adapter, a 50 Ω coaxial cable, a 50 Ω termination and the Dual Input Assembly.

d. Adjust the Constant Amplitude Signal Generator for 2 cm of 50 kHz signal.

e. Set both VOLTS/CM switches to .05.

f. Set the MODE switch to ADDED ALGEBRAICALLY.

g. Set the CHANNEL A POLARITY switch to INVERTED.

h. Check—Deflection not more than 1 cm.

i. Increase the frequency to 24 MHz.

j. Check—Deflection not more than 1 cm.

NOTE

If vertical deflection is over 1 cm, change CHANNEL A POLARITY to NORMAL and CHANNEL B POLARITY to INVERTED. One method must result in 1 cm or less deflection.

k. Change both AC-DC switches to AC.

l. Check—Deflection not more than 1 cm.

This completes the calibration of the Type CA Plug-In Unit. Disconnect all test equipment and replace the left side cover on the test oscilloscope. If the instrument has been completely calibrated to the tolerances given in this procedure, it will perform to the limits given in the Characteristics section of the Instruction Manual.

NOTES

NOTES

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geqslant$	equal to or greater than
$\leqslant$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
Θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

SECTION 7
ELECTRICAL PARTS LIST

Capacitors

Values are fixed unless marked Variable.
Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part Number		Description				S/N Range
C3300	Use *285-556	.1 μf	PTM		600 v		101-71429
C3300	*285-0672-00	.1 μf	PTM		600 V		71430-up
C3310C	281-524	150 μμf	Cer.		500 v		
C3311B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3311C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3311D††	Selected	Nominal value 10 μμf					
C3312B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3312C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3312D††	Selected						
C3312E	281-534	3.3 μμf	Cer.		500 v	±.25 μμf	
C3313B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3313C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3313D††	Selected						
C3313E	281-511	22 μμf	Cer.		500 v	10%	
C3314B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3314C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3314E	281-519	47 μμf	Cer.		500 v	10%	
C3315B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3315C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3315E	281-519	47 μμf	Cer.	Var.	500 v	10%	
C3315F	281-519	47 μμf	Cer.	Var.	500 v	10%	
C3316A†							
C3316B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3316C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3316E	283-539	250 μμf	Mica		500 v	10%	
C3317A†							
C3317B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3317C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3317E	283-541	500 μμf	Mica		500 v	10%	
C3318A††	Selected						
C3318B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3318C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3318E	283-540	750 μμf	Mica		500 v	10%	
C3321	283-003	.01 μf	Hi-Kap.		150 v	GMV	
C3322	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3345	283-001	.005 μf	Discap		500 v	GMV	
C3354	281-518	47 μμf	Cer.		500 v		
C3374	283-001	.005 μf	Discap		500 v	GMV	
C3375	281-506	12 μμf	Cer.		500 v	10%	
C3378	281-519	47 μμf	Cer.		500 v	10%	
C3385	281-506	12 μμf	Cer.		500 v	10%	
C3386	281-518	47 μμf	Cer.		500 v		X64010-up
C3388	281-519	47 μμf	Cer.		500 v	10%	
C4300	Use *285-556	.1 μf	PTM		600 v		101-71429
C4300	*285-0672-00	.1 μf	PTM		600 V		71430-up
C4310C	281-524	150 μμf	Cer.		500 v		
C4311B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4311C	281-027	.7-3 μμf	Tub.	Var.	500 v		

† Added where needed.
†† These Capacitors are selected during calibration.

Capacitors *(continued)*

Ckt. No.	Tektronix Part Number	Description				S/N Range
C4311D††	Selected	Nominal value 10 μμf				
C4312B	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4312C	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4312D††	Selected					
C4312E	281-534	3.3 μμf	Cer.		500 v	±.25 μμf
C4313B	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4313C	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4313D††	Selected					
C4313E	281-511	22 μμf	Cer.		500 v	10%
C4314B	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4314C	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4314E	281-519	47 μμf	Cer.		500 v	10%
C4315A†						
C4315B	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4315C	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4315E	281-519	47 μμf	Cer.		500 v	10%
C4315F	281-519	47 μμf	Cer.		500 v	10%
C4316A††	Selected					
C4316B	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4316C	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4316E	283-539	250 μμf	Mica		500 v	10%
C4317A††	Selected					
C4317B	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4317C	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4317E	283-541	500 μμf	Mica		500 v	10%
C4318A††	Selected					
C4318B	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4318C	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4318E	283-540	750 μμf	Mica		500 v	10%
C4321	283-003	.01 μf	Hi-Kap		150 v	GMV
C4322	281-027	.7-3 μμf	Tub.	Var.	500 v	
C4334	281-518	47 μμf	Cer.		500 v	
C4345	283-001	.005 μf	Discap		500 v	GMV
C4384	283-000	.001 μf	Discap		500 v	GMV
C4385	283-000	.001 μf	Discap		500 v	GMV
C4390	283-001	.005 μf	Discap		500 v	GMV
C4391	283-002	.01 μf	Discap		500 v	GMV
C4393	283-002	.01 μf	Discap		500 v	GMV
C4397	283-001	.005 μf	Discap		500 v	GMV
C4398	283-001	.005 μf	Discap		500 v	GMV
C4399	283-001	.005 μf	Discap		500 v	GMV

Diode

				S/N Range
D3382	*152-061	Silicon	Tek Spec	X64010-up

Inductors

L3334	*114-043	.5-1 μh	Var.	core 276-506
L3354	*114-043	.5-1 μh	Var.	core 276-506
L3360	*108-072	.75 μh		
L3361	*108-072	.75 μh		
L3362	*114-051	.9-1.6 μh	Var.	core 276-506

†† These Capacitors are selected during calibration.
† Added where needed.

Inductors *(continued)*

Ckt. No.	Tektronix Part Number	Description	S/N Range
L3364	*114-042	Special	
L3370	*108-072	.75 μh	
L3371	*108-072	.75 μh	
L3372	*114-051	.9-1.6 μh Var. core 276-506	
L4334	*114-043	.5-1 μh Var. core 276-506	
L4354	*114-043	.5-1 μh Var. core 276-506	
L4360	*108-072	.75 μh	
L4361	*108-072	.75 μh	
L4362	*114-051	.9-1.6 μh Var. core 276-506	
L4370	*108-072	.75 μh	
L4371	*108-072	.75 μh	
L4372	*114-051	.9-1.6 μh Var. core 276-506	
L4374	*114-042	Special	
L4384	*108-112	.3 μh	
L4385	*108-112	.3 μh	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R3310C	302-330	33 Ω	½ w			101-14520
	316-470	47 Ω	¼ w			14521-up
R3310E	302-470	47 Ω	½ w			101-14520
	316-470	47 Ω	¼ w			14521-up
R3311C	309-003	500 k	½ w	Prec.	1%	
R3311D	302-470	47 Ω	½ w			X25730-up
R3311E	309-014	1 meg	½ w	Prec.	1%	
R3312C	309-010	750 k	½ w	Prec.	1%	
R3312E	309-053	333 k	½ w	Prec.	1%	
R3313C	309-111	900 k	½ w	Prec.	1%	
R3313E	309-046	111 k	½ w	Prec.	1%	
R3314C	309-143	950 k	½ w	Prec.	1%	
R3314E	309-137	52.6 k	½ w	Prec.	1%	
R3315C	309-144	975 k	½ w	Prec.	1%	
R3315E	309-136	25.6 k	½ w	Prec.	1%	
R3316C	309-013	990 k	½ w	Prec.	1%	
R3316D	302-100	10 Ω	½ w			
R3316E	309-034	10.1 k	½ w	Prec.	1%	
R3317C	309-146	995 k	½ w	Prec.	1%	
R3317D	302-100	10 Ω	½ w			
R3317E	309-134	5.03 k	½ w	Prec.	1%	
R3318C	309-147	997.5 k	½ w	Prec.	1%	
R3318D	302-100	10 Ω	½ w			
R3318E	309-133	2.51 k	½ w	Prec.	1%	
R3320	309-014	1 meg	½ w	Prec.	1%	
R3321	302-105	1 meg	½ w			101-14520
	316-105	1 meg	¼ w			14521-up
R3322	302-470	47 Ω	½ w			101-14520
	316-470	47 Ω	¼ w			14521-up

Resistors *(continued)*

Ckt. No.	Tektronix Part Number		Description				S/N Range
R3323	316-470	47 Ω	¼ w				X25730-up
R3324	306-223	22 k	2 w				
R3332	302-270	27 Ω	½ w				
R3334	309-250	500 Ω	½ w		Prec.	1%	
R3337	309-132	5.6 k	½ w		Prec.	1%	
R3338	Use *311-279	770 Ω		Var.	WW	VARIABLE	
R3341	311-018	20 k	2 w	Var.		DC BAL.	
R3343	304-223	22k	1 w				101-64659
R3343	303-183	18 k	1 w			5%	64660-up
R3344	302-104	100 k	½ w				101-64659X
R3345	302-561	560 Ω	½ w				101-64659
R3345	301-681	680 Ω	½ w			5%	64660-up
R3354	309-250	500 Ω	½ w		Prec.	1%	
R3355	308-053	8 k	5 w		WW	5%	
R3356	311-015	10 k	2 w	Var.	WW	GAIN ADJ.	101-39599
	311-294	15 k	2 w	Var.	WW	GAIN ADJ.	39600-up
R3357	309-132	5.6 k	½ w		Prec.	1%	
R3360	302-154	150 k	½ w				
R3361	311-028	2 x 100 k	2 w	Var.		VERT. POS.	
R3362	302-470	47 Ω	½ w				
R3364	Use 309-102	402 Ω	½ w		Prec.	1%	
R3365	*312-591	20 k	10 w		WW	5% (1 pair, matched to ±1% of each other)	
R3366	*312-590	6 k	5 w		WW	5% (1 pair, matched to ±1% of each other)	
R3370	302-154	150 k	½ w				
R3371	306-392	3.9 k	2 w				
R3372	302-470	47 Ω	½ w				
R3373	304-562	5.6 k	1 w				
R3374	301-303	30 k	½ w			5%	
R3375	306-333	33 k	2 w				
R3376	302-471	470 Ω	½ w				
R3377	302-101	100 Ω	½ w				
R3378	301-164	160 k	½ w			5%	
R3379	301-204	200 k	½ w			5%	
R3380	302-224	220 k	½ w				
R3383	316-334	330 k	¼ w				X34790-64009
R3383	302-184	180 k	½ w				64010-up
R3385	306-333	33 k	2 w				
R3386	302-471	470 Ω	½ w				
R3387	302-101	100 Ω	½ w				
R3388	301-164	160 k	½ w			5%	
R3389	301-204	200 k	½ w			5%	
R3390	302-224	220 k	½ w				
R3393	302-472	4.7 k	½ w				
R3394	302-472	4.7 k	½ w				
R3395	304-683	68 k	1 w				
R3396	302-123	12 k	½ w				
R3398	302-101	100 Ω	½ w				
R3399	302-101	100 Ω	½ w				
R4310C	302-330	33 Ω	½ w				101-14320
	316-470	47 Ω	¼ w				14321-up
R4310E	302-470	47 Ω	½ w				101-14320
	316-470	47 Ω	¼ w				14321-up
R4311C	309-003	500 k	½ w		Prec.	1%	
R4311D	302-470	47 Ω	½ w				X25730-up
R4311E	309-014	1 meg	½ w		Prec.	1%	

Resistors *(continued)*

Ckt. No.	Tektronix Part Number		Description				S/N Range
R4312C	309-010	750 k	½ w		Prec.	1%	
R4312E	309-053	333 k	½ w		Prec.	1%	
R4313C	309-111	900 k	½ w		Prec.	1%	
R4313E	309-046	111 k	½ w		Prec.	1%	
R4314C	309-143	950 k	½ w		Prec.	1%	
R4314E	309-137	52.6 k	½ w		Prec	1%	
R4315C	309-144	975 k	½ w		Prec.	1%	
R4315E	309-136	25.6 k	½ w		Prec.	1%	
R4316C	309-013	990 k	½ w		Prec.	1%	
R4316D	302-100	10 Ω	½ w				
R4316E	309-034	10.1 k	½ w		Prec.	1%	
R4317C	309-146	995 k	½ w		Prec.	1%	
R4317D	302-100	10 Ω	½ w				
R4317E	309-134	5.03 k	½ w		Prec.	1%	
R4318C	309-147	997.5 k	½ w		Prec.	1%	
R4318D	302-100	10 Ω	½ w				
R4318E	309-133	2.51 k	½ w		Prec.	1%	
R4320	309-014	1 meg	½ w		Prec.	1%	
R4321	302-105	1 meg	½ w				101-14520
	316-105	1 meg	¼ w				14521-up
R4322	302-470	47 Ω	½ w				101-14520
	316-470	47 Ω	¼ w				14521-up
R4323	316-470	47 Ω	¼ w				X25730-up
R4324	306-223	22 k	2 w				
R4332	302-270	27 Ω	½ w				
R4334	309-250	500 Ω	½ w		Prec.	1%	
R4337	309-132	5.6 k	½ w		Prec.	1%	
R4338	Use *311-279	770 Ω		Var.	WW	VARIABLE	
R4341	311-018	20 k	2 w	Var.		DC BAL.	
R4343	304-223	22 k	1 w				101-64659
R4343	303-183	18 k	1 w			5%	64660-up
R4344	302-104	100 k	½ w				101-64659X
R4345	302-561	560 Ω	½ w				101-64659
R4345	301-681	680 Ω	½ w			5%	64660-up
R4354	309-250	500 Ω	½ w		Prec.	1%	
R4355	308-053	8 k	5 w		WW	5%	
R4356	311-015	10 k	2 w	Var.	WW	GAIN ADJ.	101-39599
	311-294	15 k	2 w	Var.	WW	GAIN ADJ.	39600-up
R4357	309-132	5.6 k	½ w		Prec.	1%	
R4360	302-154	150 k	½ w				
R4361	311-028	2 x 100 k	2 w	Var.		VERT. POS.	
R4362	302-470	47 Ω	½ w				
R4365	*312-591	20 k	10 w		WW	5% (1 pair matched ±1% of each other)	
R4366	*312-590	6 k	5 w		WW	5% (1 pair matched ±1% of each other)	
R4370	302-154	150 k	½ w				
R4372	302-470	47 Ω	½ w				
R4374	Use 309-102	402 Ω	½ w		Prec.	1%	
R4375	302-104	100 k	½ w				
R4376	311-051	2 x 100 k	2 w			Vert. Pos. & Range	
R4377	302-104	100 k	½ w				
R4382	304-182	1.8 k	1 w				
R4383	303-822	8.2 k	1 w			5%	
R4384	303-822	8.2 k	1 w			5%	

Resistors *(continued)*

Ckt. No.	Tektronix Part Number		Description			S/N Range
R4385	303-822	8.2 k	1 w		5%	
R4386	303-822	8.2 k	1 w		5%	
R4391	302-270	27 Ω	½ w			
R4393	302-270	27 Ω	½ w			
R4395	308-062	3 k	5 w	WW	5%	
R4397	306-153	15 k	2 w			

Switches

	Unwired	Wired			S/N Range
SW3300	Use 260-330		Slide	AC-DC	101-67429
SW3300	260-0451-00		Slide	AC-DC	67430-up
SW3310	*260-146	*262-118	Rotary	VOLTS/CM A	101-25729
	*260-146	*262-483			25730-up
SW3360	*260-148		Rotary	POLARITY	
SW3380	*260-244		Rotary	MODE	
SW4300	Use 260-330		Slide	AC-DC	101-67429
SW4300	260-0451-00		Slide	AC-DC	67430-up
SW4310	*260-146	*262-119	Rotary	VOLTS/CM B	101-25729
	*260-146	*262-484			25730-up
SW4360	*260-148		Rotary	POLARITY	

Electron Tubes

				S/N Range
V3323	154-014	6AK5/5654		101-71429
V3323	*157-0117-00	6AK5	Checked	71430-up
V3334	154-0040-03	12AU6		101-70049
V3334	154-0040-05	8426		70050-up
V3354	154-0040-03	12AU6		101-70049
V3354	154-0040-05	8426		70050-up
V3364, V3374	Use *157-059	6AU6	Selected pair. Furnished as a unit.	
V3375	154-039	12AT7		
V3382	154-016	6AL5		
V3384	154-039	12AT7		
V3393	154-039	12AT7		
V4323	154-014	6AK5/5654		101-41429
V4323	*157-0117-00	6AK5	Checked	41430-up
V4334	154-0040-03	12AU6		101-70049
V4334	154-0040-05	8426		70050-up
V4354	154-0040-03	12AU6		101-70049
V4354	154-0040-05	8426		70050-up
V4364, V4374	Use *157-059	6AU6	Selected pair. Furnished as a unit.	
V4383	154-039	12AT7		

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

FIG. 1 FRONT AND REAR

FIG. 2 CHASSIS

Ⓐ©

SECTION 8

MECHANICAL PARTS LIST

FIG. 1 FRONT & REAR

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-1	333-0486-00			1	PANEL, front
-2	386-0476-00			1	PLATE, sub-panel
-3	366-0029-00	101	67429	1	KNOB, black—VOLTS/CM (CHANNEL A)
	366-0142-00	67430		1	KNOB, charcoal—VOLTS/CM (CHANNEL A)
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-4	366-0031-00			1	KNOB, red—VARIABLE (CHANNEL A)
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-5	262-0118-00	101	25729	1	SWITCH, wired—VOLTS/CM (CHANNEL A)
	262-0407-00	25730	38939	1	SWITCH, wired—VOLTS/CM (CHANNEL A)
	262-0483-00	38940		1	SWITCH, wired—VOLTS/CM (CHANNEL A)
	- - - - - -			-	switch includes:
	260-0146-00			1	SWITCH, unwired, VOLTS/CM (CHANNEL A)
-6	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	resistor includes:
-7	384-0126-00			1	ROD
	213-0022-00			1	SCREW, set, 4-40 x 3/16 inch, HSS
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0906-00			2	WASHER, fiber, 1/8 ID x 13/64 inch, OD
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-8	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-9	366-0029-00	101	67429	1	KNOB, black—VOLTS/CM (CHANNEL B)
	366-0142-00	67430		1	KNOB, charcoal—VOLTS/CM (CHANNEL B)
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-10	366-0031-00			1	KNOB, red—VARIABLE (CHANNEL B)
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-11	262-0119-00	101	25729	1	SWITCH, wired—VOLTS/CM (CHANNEL B)
	262-0408-00	25730	38939	1	SWITCH, wired—VOLTS/CM (CHANNEL B)
	262-0484-00	38940		1	SWITCH, wired—VOLTS/CM (CHANNEL B)
	- - - - - -			-	switch includes:
	260-0146-00			1	SWITCH, unwired—VOLTS/CM (CHANNEL B)
-12	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	resistor includes:
-13	384-0126-00			1	ROD
	213-0022-00			1	SCREW, set, 4-40 x 3/16 inch, HSS
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0906-00			2	WASHER, fiber, 1/8 ID x 13/64 inch OD
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-14	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch

FIG. 1 FRONT & REAR *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-15	366-0047-00	101	67429	1	KNOB, black—POLARITY (CHANNEL A)
	366-0149-00	67430		1	KNOB, charcoal—POLARITY (CHANNEL A)
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-16	260-0148-00			1	SWITCH, unwired—POLARITY (CHANNEL A)
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
-17	366-0047-00	101	67429	1	KNOB, black—POLARITY (CHANNEL B)
	366-0149-00	67430		1	KNOB, charcoal—POLARITY (CHANNEL B)
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-18	260-0148-00			1	SWITCH, unwired—POLARITY (CHANNEL B)
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
-19	366-0033-00	101	67429	1	KNOB, black—VERTICAL POSITION (CHANNEL A)
	366-0148-00	67430		1	KNOB, charcoal—VERTICAL POSITION (CHANNEL A)
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-20	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-21	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-22	366-0033-00	101	67429	1	KNOB, black—VERTICAL POSITION (CHANNEL B)
	366-0148-00	67430		1	KNOB, charcoal—VERTICAL POSITION (CHANNEL B)
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-23	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-24	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-25	366-0033-00	101	67429	1	KNOB, black—MODE
	366-0148-00	67430		1	KNOB, charcoal—MODE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-26	260-0244-00			1	SWITCH, unwired—MODE
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-27	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch

FIG. 1 FRONT & REAR *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-28	- - - - - -			4		RESISTOR, variable
	- - - - - -			-		mounting hardware for each: (not included w/resistor)
-29	210-0494-00			1		NUT, hex., $^{3}/_{8}$-32 x $^{1}/_{2}$ x $^{11}/_{16}$ inch long
-30	210-0013-00			1		LOCKWASHER, internal, $^{3}/_{8}$ ID x $^{11}/_{16}$ inch OD
-31	358-0010-00			1		BUSHING, $^{3}/_{8}$-32 x $^{9}/_{16}$ x 0.412 inch long
-32	260-0145-00	101	14520	1		SWITCH, slide—AC DC (CHANNEL A)
	260-0330-00	14521	67429	1		SWITCH, slide—AC DC (CHANNEL A)
	260-0451-00	67430		1		SWITCH, slide—AC DC (CHANNEL A)
	- - - - - -			-		mounting hardware: (not included w/switch)
-33	211-0101-00			2		SCREW, 4-40 x $^{1}/_{4}$ inch, 100° csk, FHS
	210-0406-00			2		NUT, hex., 4-40 x $^{3}/_{16}$ inch
-34	260-0145-00	101	14520	1		SWITCH, slide—AC DC (CHANNEL B)
	260-0330-00	14521	67429	1		SWITCH, slide—AC DC (CHANNEL B)
	260-0451-00	67430		1		SWITCH, slide—AC DC (CHANNEL B)
	- - - - - -			-		mounting hardware: (not included w/switch)
	211-0101-00			2		SCREW, 4-40 x $^{1}/_{4}$ inch, 100° csk, FHS
-35	210-0406-00			2		NUT, hex., 4-40 x $^{3}/_{16}$ inch
-36	366-0056-00	101	28969	1		KNOB, plug-in securing
	366-0125-00	28970		1		KNOB, plug-in securing
	- - - - - -			-		knob includes:
	213-0006-00	101	28969	1		SCREW, set, 8-32 x $^{3}/_{16}$ inch, HSS
	213-0004-00	28970		1		SCREW, set, 6-32 x $^{3}/_{16}$ inch, HSS
-37	210-0894-00			1		WASHER, plastic, 0.190 ID x $^{7}/_{16}$ inch OD
-38	384-0510-00			1		ROD, plug-in securing
	- - - - - -			-		rod includes:
-39	354-0025-00			1		RING, retaining
-40	129-0053-00			2		ASSEMBLY, binding post
	- - - - - -			-		each assembly includes:
	355-0507-00			1		STEM, binding post
	200-0103-00			1		CAP, binding post
	- - - - - -			-		mounting hardware for each: (not included w/assembly)
-41	210-0223-00			1		LUG, solder, $^{1}/_{4}$ ID x $^{7}/_{16}$ inch OD, SE
-42	210-0455-00			1		NUT, hex., $^{1}/_{4}$-28 x $^{3}/_{8}$ inch
-43	131-0051-00	101	56079	2		CONNECTOR, coaxial, 1-contact, UHF
	131-0277-00	56080		2		CONNECTOR, coaxial, 1-contact, BNC
	- - - - - -			-		mounting hardware for each: (not included w/connector)
-44	211-0025-00			4		SCREW, 4-40 x $^{3}/_{8}$ inch, FHS
	210-0004-00			4		LOCKWASHER, internal, #4
-45	210-0406-00			4		NUT, hex., 4-40 x $^{3}/_{16}$ inch
	210-0961-00	X56080	60638X	2		WASHER, plastic, $^{3}/_{8}$ ID x $^{13}/_{16}$ inch OD
-46	631-0008-00			1		ASSEMBLY, plate, wired (CHANNEL A)
	- - - - - -			-		assembly includes:
	386-0861-00	101	14969	1		PLATE, plastic
	386-0942-00	14970		1		PLATE, plastic
	- - - - - -			-		mounting hardware: (not included w/assembly)
-47	211-0011-00			2		SCREW, 4-40 x $^{5}/_{16}$ inch, PHS

FIG. 1 FRONT & REAR *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-48	631-0009-00			1	ASSEMBLY, plate, wired, (CHANNEL B)
	- - - - - -			-	assembly includes:
	386-0862-00	101	14969	1	PLATE, plastic
	386-0943-00	14970		1	PLATE, plastic
	- - - - - -			-	mounting hardware: (not included w/assembly)
-49	211-0011-00			2	SCREW, 4-40 x 5/16 inch, PHS
-50	406-0206-00			1	BRACKET, right angle
-51	337-0262-00			1	SHIELD, attenuator
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0008-00			1	SCREW, 4-40 x 1/4 inch, PHS
	210-0004-00	101	64659	1	LOCKWASHER, internal, #4
	210-0406-00	101	64659	1	NUT, hex., 4-40 x 3/16 inch
	210-0586-00	64660		1	NUT, keps, 4-40 x 1/4 inch
-52	384-0508-00	101	63459	4	ROD, frame
	384-0631-00	63460		4	ROD, frame
	- - - - - -			-	mounting hardware for each: (not included w/rod)
	212-0043-00	101	64509X	1	SCREW, 8-32 x 1/2 inch, FHS
-53	212-0044-00			1	SCREW, 8-32 x 1/2 inch, RHS
-54	387-0529-00			1	PLATE, rear
-55	406-0127-00			1	BRACKET
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-56	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-57	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-58	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-59	131-0017-00			1	CONNECTOR, 16-contact, male
	- - - - - -			-	mounting hardware: (not included w/connector)
-60	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
-61	210-0201-00			2	LUG, solder, SE #4
-62	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-63	211-0538-00			4	SCREW, 6-32 x 5/16 inch, 100° csk, FHS
-64	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS

FIG. 2 CHASSIS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-1	441-0226-00	101	14024	1	CHASSIS
	441-0302-00	14025		1	CHASSIS
-2	136-0015-00			3	SOCKET, tube, 9 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-3	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-4	136-0008-00			3	SOCKET, tube, 7 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-5	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-6	136-0007-00			8	SOCKET, tube, 7 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-7	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-8	- - - - - -			2	RESISTOR
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-9	211-0553-00			1	SCREW, 6-32 x 1 1/2 inches, RHS
-10	210-0601-00			1	EYELET, 0.190 ID x 0.323 inch OD
-11	210-0478-00			1	NUT, hex., 5/16 x 21/32 inch lg.
-12	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-13	348-0004-00			2	GROMMET, rubber, 3/8 inch diameter
-14	348-0002-00			2	GROMMET, rubber, 1/4 inch diameter
-15	200-0174-00			12	CAP, screw
-16	- - - - - -			10	COIL
	- - - - - -			-	mounting hardware for each: (not included w/coil)
-17	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-18	210-0201-00			2	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
-19	211-0033-00			1	SCREW, sems, 4-40 x 5/16 inch, PHS
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0406-00			1	NUT, hex., 4-40 x 3/16 inch
-20	210-0201-00			6	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
-21	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-22	123-0007-00	101	14024	1	ASSEMBLY, turret and socket
	- - - - - -			-	assembly includes:
	123-0005-00	101	14024	1	TURRET, ceramic
	136-0015-00	101	14024	1	SOCKET, tube, 9 pin, w/ground lugs
	166-0058-00	101	14024	1	TUBE, spring, pin
	385-0116-00	101	14024	1	ROD, plastic, turret
	136-0014-00	14025		1	SOCKET, tube, 9 pin
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS

FIG. 2 CHASSIS *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-23	124-0093-00	X14025		2		STRIP, ceramic, 7/16 inch h, w/5 notches
	- - - - - -			-		each strip includes:
	355-0046-00			2		STUD, plastic
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	361-0008-00			2		SPACER, plastic, 0.281 inch long
-24	124-0060-00	101	6249	4		STRIP, ceramic, 7/16 inch h, w/5 notches
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	210-0002-00			2		LOCKWASHER, external, #2
	210-0850-00			2		WASHER, flat, 0.093 ID x 9/32 inch OD
	210-0405-00			4		NUT, hex., 2-56 x 3/16 inch
	124-0093-00	6250		4		STRIP, ceramic, 7/16 inch h, w/5 notches
	- - - - - -			-		each strip includes:
	355-0046-00			2		STUD, plastic
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	361-0008-00			2		SPACER, plastic, 0.281 inch long
-25	124-0016-00	101	6249	2		STRIP, ceramic, 3/4 inch h, w/11 notches
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	210-0002-00			2		LOCKWASHER, external, #2
	210-0850-00			2		WASHER, flat, 0.093 ID x 9/32 inch OD
	210-0405-00			4		NUT, hex., 2-56 x 3/16 inch
	124-0091-00	6250		2		STRIP, ceramic, 3/4 inch h, w/11 notches
	- - - - - -			-		each strip includes:
	355-0046-00			2		STUD, plastic
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	361-0009-00			2		SPACER, plastic, 0.406 inch long
-26	124-0012-00	101	6249	2		STRIP, ceramic, 3/4 inch h, w/4 notches
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	210-0002-00			2		LOCKWASHER, external, #2
	210-0850-00			2		WASHER, flat, 0.093 ID x 9/32 inch OD
	210-0405-00			4		NUT, hex., 2-56 x 3/16 inch
	124-0088-00	6250		2		STRIP, ceramic, 3/4 inch h, w/4 notches
	- - - - - -			-		each strip includes:
	355-0046-00			2		STUD, plastic
	- - - - - -			-		mounting hardware for each: (not included w/strip)
	361-0009-00			2		SPACER, plastic, 0.406 inch long

FIG. 2 CHASSIS *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-27	124-0066-00	101	6249	2	STRIP, ceramic, 3/4 inch h, w/9 notches
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	210-0002-00			2	LOCKWASHER, external, #2
	210-0850-00			2	WASHER, flat, 0.093 ID x 9/32 inch OD
	210-0405-00			4	NUT, hex., 2-56 x 3/16 inch
	124-0090-00	6250		2	STRIP, ceramic, 3/4 inch h, w/9 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
-28	179-0274-00	101	14024	1	CABLE HARNESS
	179-0399-00	14025		1	CABLE HARNESS

STANDARD ACCESSORIES

	070-0318-01			2	MANUAL, instruction (not shown)

V3323
V4323
INPUT CF'S

V3334 V4334
V3354 V4354
INPUT AMPLIFIERS

V3364 V4364
V3374 V4374
OUTPUT AMPLIFIERS

CHANNEL A

AC DC

SW3300

SW3310
VOLTS/CM

C3321 .01

V3323
6AK5 OR 5654*

R3322 47

R3321 1M

R3323 47

C3322 0.7-3

R3320 1M

C3300 0.1

1F 2R

20 10 5 2 1 .5 .2 .1 .05

x400 x200 x100 x40 x20 x10 x4 x2 x1

+100V

R3324 22K

-150V

V3334
12AU6

L3334 0.5-1μh

L3360 0.75μh

L3361 0.75μh

L3362 0.9-1.6μh

NORMAL

INVERTED

R3332 27

R3334 500

GAIN ADJ.

R3356 1.5K

R3355 8K

R3337 5.6K

+2.6

VARIABLE

R3338 770

R3357 5.6K

+2.6

V3354
12AU6

+100V

R3344 100K

DC BAL.

R3343 18K

R3341 20K

+12.5V

C3345 .005

R3345 680

R3354 500

L3354 0.5-1μh

L3370 0.75μh

VERTICAL POSITION

1R 1R

POLARITY
SW3360

+69V

R3364 402

V3364
6AU6

L3364

+37.5V

+32.8

R3362 47

+38.5

3R

R3366 6K

R3365 20K

-150V

+65

R3360 150K

+225V

R3361 2x100K

R3370 150K

+12.5V

L3371 0.75μh

L3372 0.9-1.6μh

+32.8

R3372 47

+37.5V

+56.7

V3374
6AU6

TO V3375, V3382, V3384, V3393, V3364, V3374, V4364, V4374

C4398 .005

6.3VAC

TO SWITCHING CIRCUIT

-150V

R4391 27

C4391 .01

+350V

OUTPUT CF'S
+350V

R4382 1.8K

TO C3386

R4383 8.2K

V4383A
½12AT7

+243.9

L4384 0.3μh

+66

R4384 8.2K

C4384 .001

C4385 .001

R4385 8.2K

L4385 0.3μh

+66

V4383B
½12AT7

+243.9

+65

L4374

R4386 6.2K

R4374 402

+69V

C4390 .005

3F

V3375 SWITCHING MULTIVIBRATOR
V3382 TRIGGER COUPLING DIODE
V3384 SHAPER
V3393 SWITCHING CF'S

V3382
6AL5

+225V

R3383 180K

C3386 47

D3382

+175

INTERCONN. PLUG 16

20V/CM

5mS/CM

0V

C3375 12

C3385 12

10V/CM

2μS/CM

0V

SWITCHING CIRCUITRY

+225V

R3375 33K

R3385 33K

R3378 160K

R3388 160K

V3375A
½12AT7

V3375B
½12AT7

C3378 47

C3388 47

R3377 100

R3387 100

R3380 220K

R3379 200K

R3389 200K

R3390 220K

-150V -150V

R3376 470

R3386 470

+1.1

+225V

+225V

+225V

+225V

1F 1R 2R

1F 1R 2R

+37.5V

R3393 4.7K

V3393A
½12AT7

R3398 100

+225V

V3384A
½12AT7

+37.5V

R3396 12K

ADDED ALGEBRAICALLY

CHOPPED

ALTERNATE

B ONLY

A ONLY

+2.2

R3395 68K

-150V

1V/CM

0V-DC

5ms/CM

V3384B
½12AT7

3F

+34

C3354 47

SW3380
MODE

+225

V3393B
½12AT7

R3399 100

+34

C4334 47

+37.5V

R3394 4.7K

SW4360
POLARITY

IR IR

+32.8

NORMAL

INVERTED

+32.8

L4361 0.75μh

L4362 0.9-1.6μh

R4360 150K

+225V

R4361 2x100K

R4370 150K

+12.5V

L4371 0.75μh

L4372 0.9-1.6μh

VERTICAL POSITION

V4364
6AU6

+37.5V

R4362 47

+65

C3374 .005

R3374 30K

+38.5

R4366 6K

R4365 20K

-150V

V4374
6AU6

+37.5V

+65

R4372 47

+32.8

R4376 2x100K

R4373 100K

+225V

VERT. POS. RANGE

R4377 100K

+12.5V

2F

R4371 3.9K

R3373 5.6K

+100V

+225V

AC DC

SW4300

CHANNEL B

SW 4310
VOLTS/CM

AC DC

C4300 0.1

1F 2R

20 10 5 2 1 .5 .2 .1 .05

x400 x200 x100 x40 x20 x10 x4 x2 x1

C4321 .01

R4321 1M

R4320 1M

R4323 47

R4322 47

C4322 0.7-3

+100V

V4323
6AK5 OR 5654*

R4324 22K

-150V

GAIN ADJ.

R4356 1.5K

R4355 8K

R4337 5.6K

+2.6

R4334 500

L4334 0.5-1μh

R4332 27

V4334
12AU6

R4338 770

VARIABLE

+2.6

R4357 5.6K

V4354
12AU6

+100V

DC BAL.

R4343 18K

R4341 20K

+12.5V

C4345 .005

R4345 680

L4354 0.5-1μh

R4354 500

L4360 0.75μh

L4370 0.75μh

+100V

+100V

+100V

R4344 100K

+100V

+37.5V

+12.5V

V3323

V3354

V3334

V3383

V4323

V4354

V4334

V4383

C4399 .005

C4397 .005

R4397 15K

2F

+75V@150MA

TO PIN 1, V3382 TRIGGER COUPLING DIODE

INTERCONNECTING PLUG

R4393 27

C4393 .01

R4395 3K

+100V

+69V

+225V

+37.5V

VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

VOLTS/CM	.05
VARIABLE	FULL CW
POLARITY	(+)
AC-DC	DC
MODE	ALTERNATE
TEST OSCILLOSCOPE	
TIME/CM	0.5 MS/CM

* NOTE:
TYPE 5654 MAY BE FOUND IN SOME INSTRUMENTS

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE

AE1

IMPORTANT:
ALL CIRCUIT VOLTAGES WERE OBTAINED WITH A 20,000Ω/V VOM. ALL READINGS ARE IN VOLTS.

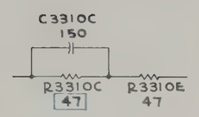
VOLTAGE AMPLITUDE MEASUREMENTS, AS SHOWN, ARE NOT ABSOLUTE. THEY MAY VARY BETWEEN INSTRUMENTS AS WELL AS WITHIN THE INSTRUMENT ITSELF DUE TO NORMAL MANUFACTURING TOLERANCES, AND TRANSISTOR AND VACUUM TUBE CHARACTERISTICS.

TYPE CA PREAMPLIFIER

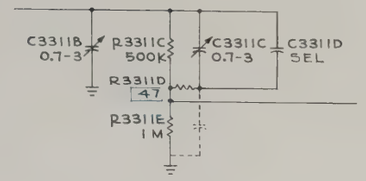
JN
1264

CHANNEL A

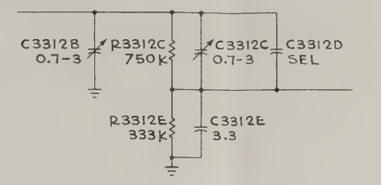
X1 (.05V/CM)



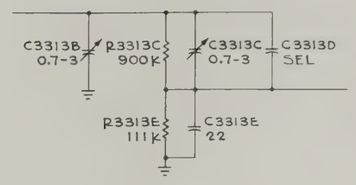
X2 (.1V/CM)



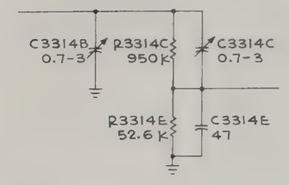
X4 (.2V/CM)



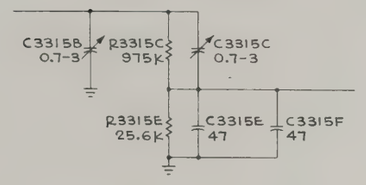
X10 (.5V/CM)



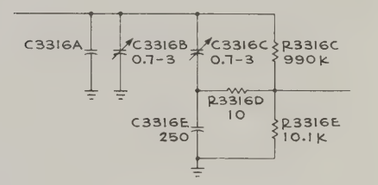
X20 (1V/CM)



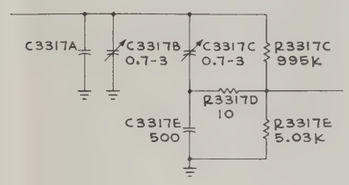
X40 (2V/CM)



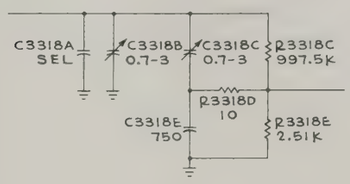
X100 (5V/CM)



X200 (10V/CM)

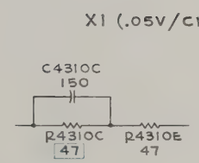


X400 (20V/CM)

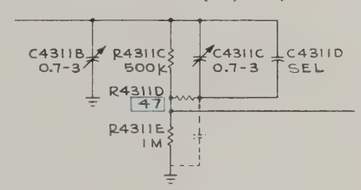


CHANNEL B

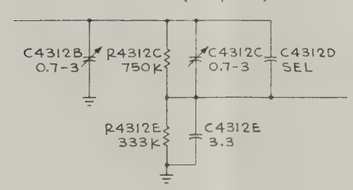
X1 (.05V/CM)



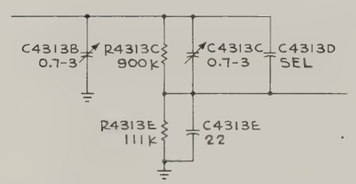
X2 (.1V/CM)



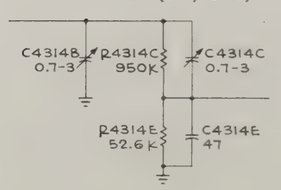
X4 (.2V/CM)



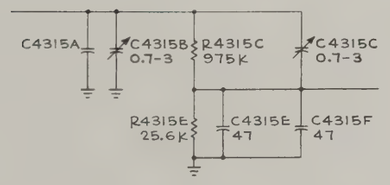
X10 (.5V/CM)



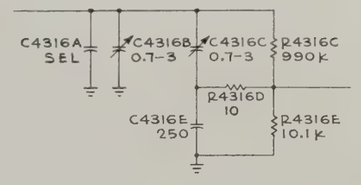
X20 (1V/CM)



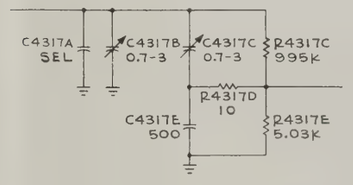
X40 (2V/CM)



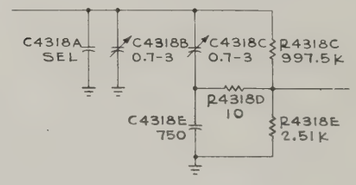
X100 (5V/CM)



X200 (10V/CM)



X400 (20V/CM)



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE

AC3

TYPE CA ATTENUATION NETWORKS

10-5-61

FIG. 1 FRONT AND REAR

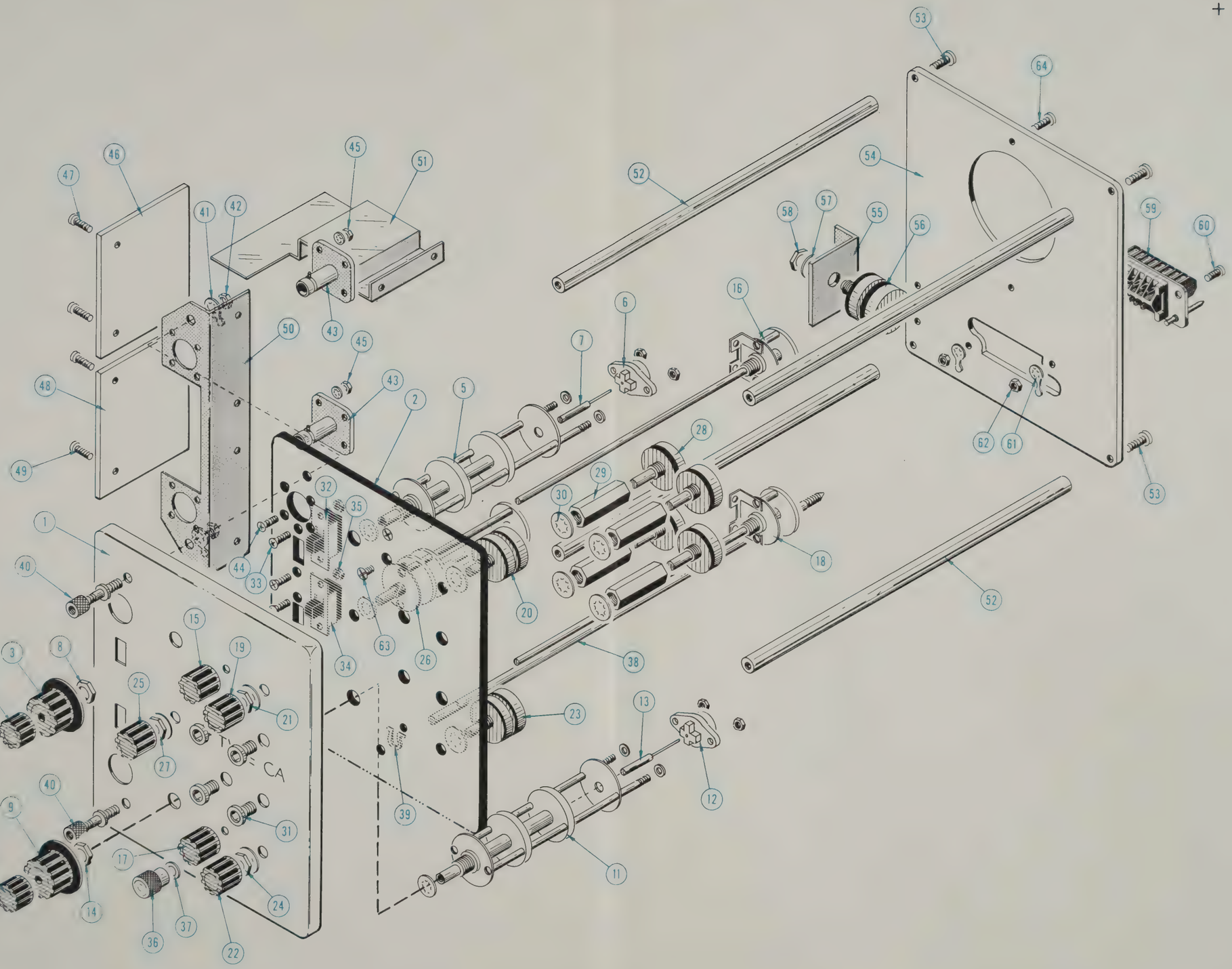
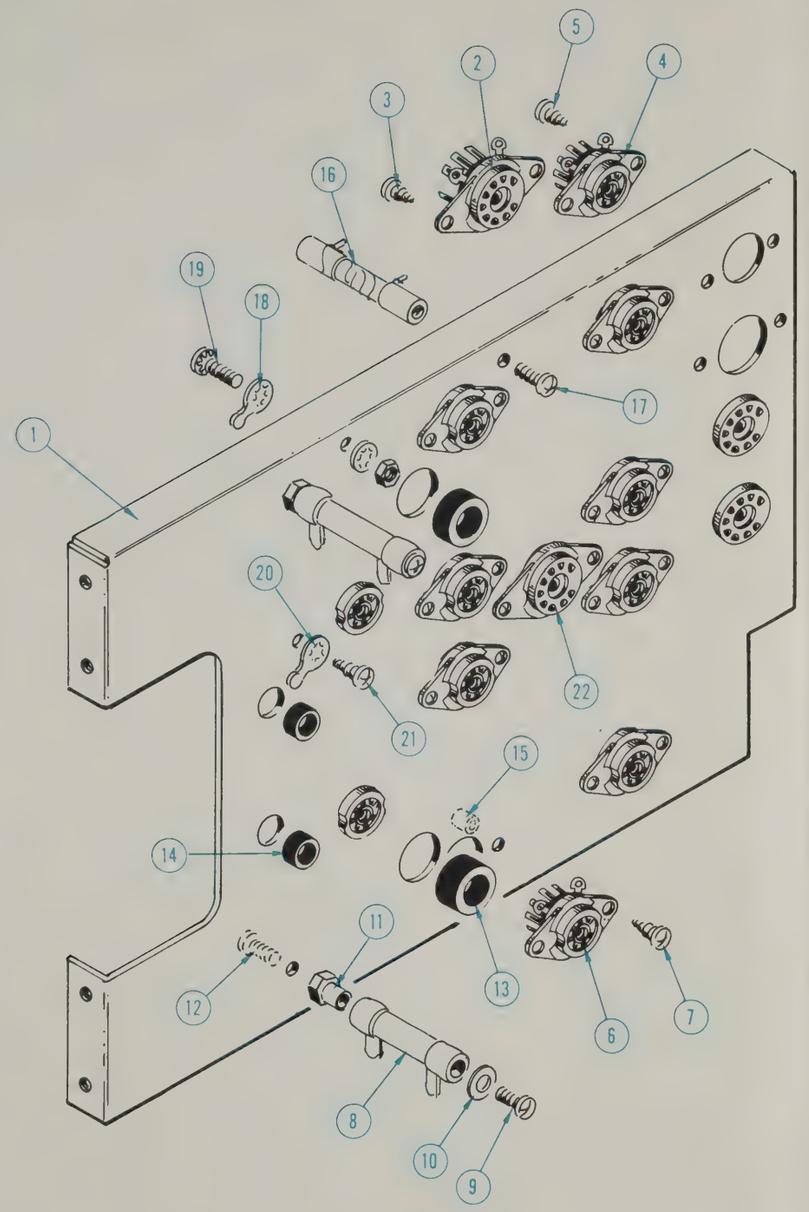
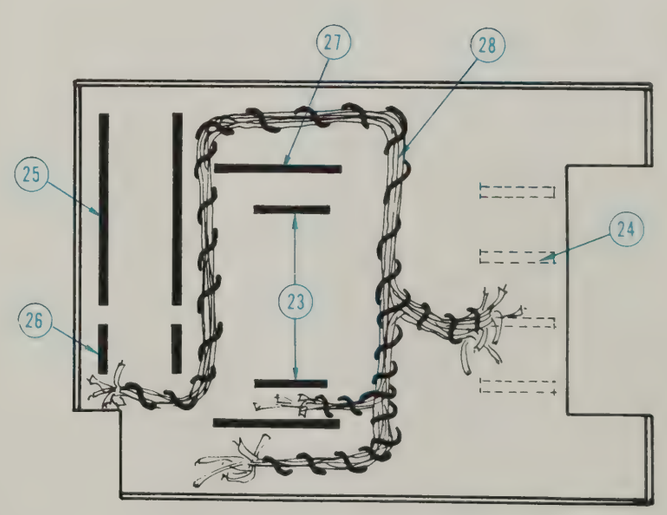


FIG. 2 CHASSIS





MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE CA TENT SN 71430

PARTS LIST CORRECTION

CHANGE TO:

V3323, V4323	157-0117-00	6AK5, Selected

TYPE CA TENT SN 71430

PARTS LIST CORRECTION

CHANGE TO:

C3300, C4300	285-0672-00	0.1 µF	600 V	PTM